# NINTH ANNUAL REPORT

OF THE

## NEW JERSEY STATE

# Agricultural Experiment Station

AND THE

## FIRST ANNUAL REPORT

OF THE

# New Jersey Agricultural College Experiment Station

FOR THE YEAR

1888.

TRENTON, N. J.:
THE JOHN L. MURPHY PUBLISHING CO., STATE PRINTERS
1889.

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## NEW JERSEY STATE

# Agricultural Experiment Station

*With the Compliments of*

GEO. H. COOK,

Director N. J. Agricultural Experiment Station,

NEW BRUNSWICK, N. J.

*Please acknowledge receipt.*

1888.

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*To his Excellency Robert S. Green, Governor of the State of New Jersey:*

SIR—I have the honor to submit herewith the ninth annual report of the New Jersey State Agricultural Experiment Station, as required by the law establishing the Station, which was approved March 10th, 1880, and which is chapter CVI. of the laws of that year.

JOHN DE MOTT,
*President.*

NEW BRUNSWICK, N. J., December 31st, 1888.

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Prof. of Agriculture of State Agricultural College.

FIRST CONGRESSIONAL DISTRICT.

| | *Residences.* | *Terms Expire.* |
|---|---|---|
| Hon. Thomas H. Dudley, | Camden, | 1890. |
| I. M. Smalley, Esq., | Roadstown, | 1890. |

SECOND CONGRESSIONAL DISTRICT.

| | | |
|---|---|---|
| John I. Bishop, | Columbus, | 1889. |
| Ralph Ege, | Hopewell, | 1890. |

THIRD CONGRESSIONAL DISTRICT.

| | | |
|---|---|---|
| John V. N. Willis, Esq., | Marlboro, | 1890. |
| James Neilson, Esq., | New Brunswick, | 1890. |

FOURTH CONGRESSIONAL DISTRICT.

| | | |
|---|---|---|
| John De Mott, Esq., | Middlebush, | 1889. |
| Caleb Wyckoff, Esq., | Belvidere, | 1890. |

FIFTH CONGRESSIONAL DISTRICT.

| | | |
|---|---|---|
| Rev. Oliver Crane, M.D., D.D., | Morristown, | 1889. |
| Samuel R. Demarest, Jr., | Hackensack, | 1890. |

SIXTH CONGRESSIONAL DISTRICT.

| | | |
|---|---|---|
| Wm. M. Force, Esq., | Newark, | 1889. |
| Wm. R. Ward, | Newark, | 1890. |

SEVENTH CONGRESSIONAL DISTRICT.

| | | |
|---|---|---|
| Abraham W. Duryee, Esq., | New Durham, | 1890. |
| James Stevens, Esq., | Jersey City, | 1890. |

## ORGANIZATION

OF THE

## NEW JERSEY STATE AGRICULTURAL EXPERIMENT STATION.

# OFFICERS OF THE BOARD.

JOHN DE MOTT, Esq., Middlebush....................................President.
ABRAHAM W. DURYEE, Esq., New Durham. ..........................Vice President.
JAMES NEILSON, Esq., New Brunswick.................................Treasurer.
Prof. GEORGE H. COOK, LL.D., New Brunswick. .................Secretary.

# OFFICERS OF THE STATION.

Prof. GEORGE H. COOK, LL.D., New Brunswick......Director.
ARTHUR T. NEALE, Ph.D., New Brunswick .......... Chemist.
EDWARD B. VOORHEES, A.M., New Brunswick .....First Assistant Chemist.
HENRY R. BALDWIN, Jr., New Brunswick.............Second Assistant Chemist.
LOUIS A. VOORHEES, A.M., since April 24th............Third Assistant Chemist.
WILLIAM S. MYERS, New Brunswick, July 1st to
September 20th ...............................................Fourth Assistant Chemist.
IRVING S. UPSON, A.M., New Brunswick .................Clerk.
ELLIS R. WOODRUFF, New Brunswick.....................Mailing Assistant.

DAVID L. SCUDDER, New Brunswick......................Laboratory Attendant.

ORGANIZATION

OF THE

## NEW JERSEY AGRICULTURAL COLLEGE EXPERIMENT STATION.

## BOARD OF CONTROL.

The Board of Trustees of Rutgers College in New Jersey.

## EXECUTIVE COMMITTEE OF THE BOARD.

MERRILL EDWARDS GATES, Ph.D., LL.D., L.H.D., President of Rutgers College, Chairman.

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HON. HENRY W. BOOKSTAVER, LL.D.,

HENRY R. BALDWIN, M.D.,

JAMES NEILSON, Esq.

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PROF. GEORGE H. COOK, LL.D., Director.

REV. GEORGE D. HULST, A.M., Entomologist.

PROF. HORACE B. PATTON, Ph.D., Chemical Geologist, and Investigator of Soils.

PROF. JULIUS NELSON, Ph.D., Biologist, and Investigator of Food-Products of State.

PROF. BYRON D. HALSTED, Sc.D., Horticulturist and Botanist.

IRVING S. UPSON, A.M., Disbursing Clerk and Librarian.

# TREASURER'S REPORT.

James Neilson, in account with the New Jersey Agricultural Experiment Station, January 1st, 1888, to January 1st, 1889:

RECEIPTS.

| | |
|---|---|
| From State Treasurer | $12,119 41 |

PAYMENTS.

| | |
|---|---|
| Salaries and pay of chemists and assistants | $5,698 92 |
| Expenses of the Board of Managers | 51 49 |
| Stationery, including envelopes for Bulletins and Reports | 186 09 |
| Printing | 605 05 |
| Postage | 105 35 |
| Telephone and telegraph service | 93 41 |
| Fuel and stoves | 70 50 |
| Gas and water | 59 48 |
| Laboratory expenses | 224 59 |
| Field and feeding experiments | 445 88 |
| Freight, express and cartage bills | 35 90 |
| Expenses collecting samples of fertilizers | 20 13 |
| Traveling expenses | 40 29 |
| Rent | 393 00 |
| Miscellaneous and incidental expenses | 16 03 |
| Building, including insurance on new Laboratory | 4,073 30 |
| | $12,119 41 |

Respectfully submitted,

JAMES NEILSON,

*Treasurer.*

The auditing Committee of the Experiment Station have examined the accounts of the Treasurer of said Station and find them correct.

SAMUEL R. DEMAREST, Jr.,
WM. M. FORCE,

*Auditing Committee.*

# REPORT OF THE DIRECTOR.

The ninth annual report of the New Jersey Agricultural Experiment Station, which is herewith made, is joined with that of the New Jersey Agricultural College Experiment Station, the first report of which is also here presented. Both Stations are established for the benefit of agriculture and its improvement by scientific experiments and investigations, conducted by specialists who are provided with the necessary buildings and equipments, occupying common ground, and with fields wide enough for the occupancy of both; their managers at the outset voted that the work of one should supplement that of the other, and during the past year it has been carried on in accordance with the spirit of the above vote.

The work of the New Jersey Experiment Station continues to be applied to the analysis of fertilizers, feeds and fodders, and the questions connected with the production and the quality of milk. Various field experiments have also been continued, in particular experiments connected with the production of sorghum and sugar. And in general it continues work upon those subjects which have been considered to almost come within the police jurisdiction of the State. Its officers are chemists, of whom 4 or 5 are employed, and its questions mostly chemical. The Agricultural College Experiment Station takes up the work where it is necessarily left by the State Station, and continues it farther and devotes more attention to the investigation of the principles of science which underlie the various branches of agricultural and horticultural practice. It has a botanist and horticulturist, whose experiments are with the quality of seeds, the growth of staple crops, the diseases of plants and the conditions requisite for healthy growth and development. It employs an entomologist, whose attention is given to studying the habits of insects both useful and injurious, and to experiments for benefiting the one and destroying the other. It engages the services of an accomplished biologist, who has thus far given his attention mainly to studying our resources of fish

and shell fish, and in particular to the oyster industry of the State and the field for its productive increase and its extension. It has a chemical geologist, whose attention is given to the study of soils, marls and limestones, and the changes to be wrought in soils by proper tillage. Other specialists will be called in as the demands of the farmers may require.

The organizations of the two Stations are given in this report, and their united forces can do much more for the improvement of our agriculture than the two could if working in different and separate places.

The State Station has never had any laboratory or other building of its own, but has occupied rooms in the buildings of Rutgers College. The enlargement of the Agricultural College, by the addition of an Agricultural Experiment Station, and the increased work of the State Station, made it necessary to provide additional buildings. The Legislature of 1888 appropriated $30,000 for the erection of a laboratory for the Station. A liberal friend gave the land on which to build it; the United States appropriation to the Agricultural College Experiment Station authorized the expenditure of $3,000 in providing buildings, and money saved from the annual appropriation for the State Station has further increased the building fund, so that in all it will amount to near $40,000. The new laboratory is inclosed, and it is expected that it will be finished by the opening of the spring of 1889. It is a building of stone and pressed brick, 100 feet long and 50 feet wide, with two full stories, a high and well-lighted basement, and an attic with capacity equal to either of the other stories. This building will provide ample accommodations for the chemists, chemical geologists, botanists, biologists, entomologists and other specialists who may be engaged in experiment work, and will also have rooms for laboratories, lectures, farmers' meetings, &c.

In the prosecution of the Station work, analyses have been made of 170 complete fertilizers, 78 incomplete fertilizers, 33 miscellaneous specimens; also 9 analyses of feeds and fodders have been made. Field experiments have been made upon wheat, peach trees, millet, upon alfalfa, upon sorghum and upon the effect of different simple and mixed fertilizers upon crops. Experiments have also been made for destroying noxious insects. Important investigations have been begun upon the sources for the supply of fish and shell fish from our own waters, and the means for their improvement. Investigations

have also been commenced for the description and classification of the different soils of the State, and the agencies which may be applied to develop their best natural productiveness. On all these points fuller information is presented in the body of this report.

The preparation for enlarged work has necessarily interfered with the prosecution of some of the Station investigations. And a number which have been entered upon are not sufficiently advanced to give any practical results, though they are well opened. The value of our waters for the production of food fish and shell fish has never been appreciated. Our best oyster lands will produce more than ten times as much value as our average farms do. There are more than 150,000 acres of them. They are not all improved, though they are capable of as much improvement as any farm land. We have 13,000 acres in lakes, ponds and running streams. In all these fish can be cultivated, and the value to be produced from them is quite as large as that from an equal area of good upland. This value has not been realized up to the present time, but those best informed upon the subject say that it can and ought to be done. And our biologist enters upon the subject with confidence that he can contribute something to this end.

The study of soils and their properties and composition, has not in recent times received the attention it deserves. It is easier to apply fertilizers than it is to get out the natural richness of the soil. But it is by no means certain that it is more profitable. Thorough and good tillage may develop in a soil sources of fertility which under ordinary treatment are totally unavailable. There are, in our State, soils which have, within six inches of their surface, enough potash and phosphoric acid to supply the crops for a hundred years to come, and a good stock of nitrogen and the other elements of fertility. They need more complete exposure to the benignant influences of air, moisture and warmth. There are still in New Jersey 2,069,819 acres of upland unimproved, of which more than half are now capable of profitable cultivation. Some of them will need fertilization, but they will respond to thorough tillage, and give full return for all the work bestowed upon them.

Arrangements are also made for a careful and thorough trial of the leading breeds of dairy cows, so as to help determine the cost of their keep and the value of their product. The trial will need to be conducted both at the cow-stables and in the laboratory, and to be continued for at least three years.

The results of the investigations upon the growth of sorghum, and the manufacture of sugar, demonstrate that good crops of cane can be grown upon the soils of southern New Jersey by the aid of rather inexpensive fertilizers, and that by the diffusion process nine-tenths of the sugar can be extracted in a solution but very little weaker than the natural juice. The present experience is that the sorghum-sugar manufacture can be carried on to good advantage, and with good efficiency of labor and capital, in sugar-houses working not more than 40 tons of cane daily, and that with a season of seventy days, which may be reasonably expected, 2,800 tons of cane may be worked in the mill, and a product of 232,000 pounds of sugar, and 30,800 gallons of syrup obtained. This amount can be grown upon 250 acres of ground, and may be produced upon a farm of 1,250 acres without materially diminishing the other crops of the farm.

This is the present condition of the manufacture where the cane yields only 8 per cent. of sugar and the season of manufacture is limited to seventy days. But there are now single canes to be found which yield 12 and even 14 per cent. of sugar, and by careful selection and cultivation it may reasonably be expected that the whole crop may be enriched up to this standard, as it has been in the case of the sugar beet. There is no staple crop now cultivated in our country which gives promise of such good returns or of so great improvement as this; neither is there one in which a mixed industry of agriculture and manufactures can be so generally distributed.

The benefits coming to our farmers from the work of the Experiment Station continue to be satisfactory. Seven bulletins have been sent out since the issue of the last annual report, and the mailing list is increased to nearly 11,000. The early and wide distribution of the results of the Station work quickens attention and brings useful information to the farmers. The sale of fertilizers is to a large extent regulated by the analyses made at the Station laboratory. The inquiries made by farmers are of more than daily occurrence, and they indicate a marked and large increase of knowledge of the principles of agriculture. The correspondence started by these inquiries is constituting an important part of the Station work, and the inquiries made and answers given, when recorded, will become an important part of our reports.

There has been no very marked change in the amount of chemical fertilizers used in the State during the past year. From the nearest

estimates the Station can make, about 33,600 tons have been sold to our farmers, with a value of $1,125,800. The analyses show that the respectable manufacturers are becoming more careful to make their goods conform closely to their published guarantees of composition. But few brands of spurious or of greatly overrated fertilizers have been sold to our farmers, and these must have been in very small quantities. The following-named specimens are open to the criticism mentioned, viz.:

Cary Brothers' Excelsior No. 1, Station Number 2,134, is also, in its Station valuation, very far below the selling price. It does not, in its printed analysis, promise much commercial value. There is no occasion for a farmer to complain if he buys this. An intelligent examination of the analysis printed on the bags or packages will show how little of valuable fertilizing material is in them.

Jeptha A. Wagener's $55 Mineral Fertilizer, Station Number 2,583, it will be seen, comes, in its valuation, far below the price at which it is sold; and it also comes below the manufacturer's guarantee as printed in the analysis.

American Chemical Guano, Station Number 2,601, represents brands occasionally found which are not accompanied by any analysis, which, from the Station's analysis and valuation, is worth, in market, $15.11 per ton, while its selling price is $45 per ton, or almost three times its proper price. For cases like this, too, the buyer has only himself to blame; no high-priced fertilizer should be bought unless accompanied by a guaranteed analysis.

In examining the analyses, attention need only be given to the lower quantity of each ingredient, as this is all the manufacturer guarantees; thus, if the analysis is nitrogen, 2 to 3 per cent., the maker only guarantees 2 per cent., and purchasers should not fail to use these in calculating the values of the fertilizers. In the sample 2,691 the constituents are quite up to the guarantees, but in using these guarantees with the Station's prices, which are given on the next page, it will be found that its commercial value is only $16.62 per ton, while its selling price is $32, or almost twice as much as it would cost in market. When these analyses are plainly given, buyers have only themselves to blame if they pay more for their fertilizers than they are worth in market.

The prices of fertilizers have been fully maintained throughout the year, and those of some kinds of stock have increased, so that manufacturers are asking to have the Station prices for the coming year increased a little.

It is only just to here acknowledge the assistance rendered to the Station by the gentlemen who have collected the samples of fertilizers which have been analyzed. Justice to the manufacturers, sellers and buyers of fertilizers requires the samples should be taken by disinterested men, whose character and standing are well known in their communities, and above question. The following are the names of those who have collected during the last season:

| | |
|---|---|
| Charles Kraus, | Egg Harbor City, Atlantic County. |
| J. B. Eckerson, | River Vale, Bergen County. |
| Caleb S. Ridgway, | Columbus, Burlington County. |
| I. W. Nicholson, | Camden, Camden County. |
| J. H. Richardson, | Rio Grande, Cape May County. |
| Theo. F. Baker, | Bridgeton, Cumberland County. |
| Wm. R. Ward, | Newark, Essex County. |
| Jas. C. Griscom, | Woodbury, Gloucester County. |
| A. J. Thompson, | Readington, Hunterdon County. |
| Franklin Dye, | Trenton, Mercer County. |
| J. M. White, | New Brunswick, Middlesex County. |
| J. H. Denise, | Freehold, Monmouth County. |
| J. J. Mitchell, | Whippany, Morris County. |
| Geo. A. MacBean, | Lakewood, Ocean County. |
| John Grundy, | Paterson, Passaic County. |
| Woodnutt Pettit, | Salem, Salem County. |
| J. S. Ten Eyck, | North Branch, Somerset County. |
| D. R. Warbasse, | Hunt's Mills, Sussex County. |
| Dennis C. Crane, | Roselle, Union County. |
| Samuel J. Hixson, | Bridgeville, Warren County. |

It has been the aim of the Station to have its annual report ready for issue at the annual meeting of the Board of Managers, on the third Tuesday of January in each year. On account of delays in finishing work already begun, and a desire to get the results of work done, in the hands of farmers at as early a day as possible, the reports have not been completed as early as proposed, and last year the report for 1887 was not ready for distribution till in April. An effort is now made to issue a report upon the work done at the beginning of the year, though it can include only the results obtained since April last.

The plans of the State Station for work this year included an account

of the present condition and working of the beet-sugar industry in Europe, and Dr. Neale, the chemist of the Station, has devoted much time in preparing for and making the trip to Europe, and since his return the working of the sorghum sugar-house in Cape May and the report upon the season's work *there*, have occupied his time quite up to the end of the year, and his removal to the directorship of the Delaware Experiment Station has necessarily left our plans incomplete. The ordinary routine of the laboratory work has been well done by the assistant chemists of the Station, and the result of their season's work comes first in this report. Dr. Neale's work on sorghum follows under his own name, and then the several papers by the members of the Agricultural College Experiment Station staff in succession.

GEORGE H. COOK,
*Director.*

# REPORT OF THE CHEMISTS.

## FERTILIZERS.

In this portion of its work the Station aims to publish all available information regarding the purchases, the sales and the uses of commercial fertilizers. The methods of securing this information remain unchanged year after year; the form of this report consequently remains unaltered.

This remark applies only to the kind of work done; its quantity is steadily increasing, and at present fully equals the capacity of this laboratory.

The subject is considered under the following divisions:

### I.

### FERTILIZER STATISTICS.

1. The quantity and value of the fertilizers used in New Jersey during the year 1888.

2. Comparison of this year's trade with that of the four preceding years.

### II.

### THE COMMERCIAL RELATIONS OF FERTILIZERS.

1. Their market prices.

2. The sources and quality of their nitrogen, phosphoric acid and potash.

3. Their guaranteed chemical composition and relative commercial values.

### III.

### AGRICULTURAL RELATIONS OF FERTILIZERS.

1. To show that commercial fertilizers, when used upon suitable soils, not only give immediate returns, but also increase the crop-producing power of the ground.

2. To test the relative value to the crop following the one upon which it is applied of the phosphoric acid secured from bones and from S. C. rock.

## I.

## FERTILIZER STATISTICS.

*1. The quantity and value of the fertilizers used in New Jersey during the year 1888.*

*2. Comparison of this year's trade with that of the four preceding years.*

These statistics were taken by manufacturers from their books in answer to requests made by this Station. The reports were in each case returned on printed forms, of which the following is a copy:

### SALES OF COMMERCIAL FERTILIZERS.

The following is a correct statement of the number of tons of the several classes of Commercial Fertilizers sold in New Jersey by ——— ——— during the year ending November 1st, 1888:

Number of tons of Complete Manure.............................................................
" " Ammoniated Superphosphate without Potash (Dissolved Bone, &c.)... ..........................................................
" " Ground Bone.............................. ..............................
" " Kainit.... ...........................................................
" " Muriate of Potash...............................................
" " Nitrogenous Matter.............................................
(*a*) Ammonium Sulphate......................................
(*b*) Sodium Nitrate.................................................
(*c*) Blood, Ammonite, &c.........................................
Number of tons of Plain Superphosphates, including both Dissolved Bone Black and S. C. Acid Phosphate.........................................

The above circular was mailed to 72 firms, 44 of which, including those that have the largest sales in this State, forwarded itemized statements. These indicate a total consumption in New Jersey of 33,633 tons, divided as follows:

1.

THE QUANTITY AND VALUE OF THE FERTILIZERS USED IN NEW JERSEY DURING THE YEAR 1888.

| | Tons reported as sold in New Jersey. | Retail price per ton. | Total value. |
|---|---|---|---|
| Complete Manures | 25,413 | $34 83 | $885,135 |
| Dissolved Bones, &c | 1,016 | 31 90 | 32,410 |
| Ground Bones | 2,036 | 33 76 | 68,735 |
| Kainit | 604 | 12 83 | 7,749 |
| Muriate of Potash | 449 | 42 33 | 19,006 |
| Ammonite, Dried Blood, &c | 1,703 | 36 66 | 62,432 |
| Ammonium Sulphate | 53 | 69 70 | 3,694 |
| Sodium Nitrate | 157 | 52 00 | 8,164 |
| Bone Black Superphosphate | 457 | 24 80 | 11,334 |
| S. C. Rock Phosphate | 1,745 | 15 60 | 27,222 |
| Total number of tons and value | 33,633 | ............ | $1,125,881 |

It is admitted that these statistics are incomplete, as they represent 44 manufacturers only of the 72 whose brands have this year been sampled in this State and analyzed by this Station.

As stated in the annual report for 1887, this statistical work is carried out without legal authority, the data being secured only through the courtesy of those manufacturers who, year after year, at their own expense, compile their reports in answer to direct requests.

The Inspectors who represent this Station, report the retail prices of every brand sampled by them. These reports furnish the data from which the above average retail price for complete manures was obtained.

The average retail prices for kainit and all other products tabu-

lated below it were furnished by manufacturers, consequently they do not include charges for freight, cartage, &c.

The complete manures represent 76 per cent. of the total number of tons sold last season, and 80 per cent. of the total value of all sales.

2.

## COMPARISON OF THIS YEAR'S TRADE WITH THAT OF THE FOUR PRECEDING YEARS.

The total consumption for the year 1888 is reported to have been 33,633 tons. This total tonnage is eight per cent. greater than that reported in 1887, but the distribution has changed in such a manner as to increase the sales of complete fertilizers nearly thirteen per cent.

The manner in which the average retail prices for the year were secured has been already given; the fact has also been demonstrated that, of the total expenditure for fertilizers, *eighty* per cent. was paid for complete manures.

The table shows that the average prices for these complete fertilizers fell steadily from 1882 to 1887, when it was fifteen per cent. lower, and that the average price of this year is almost identical with that of 1887.

TONNAGE OF FERTILIZERS USED IN NEW JERSEY.

| | 1882. | 1884. | 1885. | 1886. | 1887. | 1888. |
|---|---|---|---|---|---|---|
| Number of tons of Complete Manure | 15,941 | 21,894 | 22,424 | 24,498 | 22,500 | 25,413 |
| " " Ammoniated Superphosphate without Potash (Dissolved Bone, &c.) | 1,370 | 1,541 | 1,603 | 1,343 | 1,898 | 1,016 |
| " " Ground Bones | 2,509 | 3,172 | 2,237 | 2,338 | 2,465 | 2,036 |
| " " Kainit | 683 | 991 | 584 | 1,106 | 1,220 | 604 |
| " " Muriate of Potash | 144 | 291 | 331 | 255 | 314 | 449 |
| " " Ammonite | 719 | 783 | 250 | *698 | ........ | *1,703 |
| " " Ammonium Sulphate | 76 | 54 | 55 | 21 | 95 | 53 |
| " " Sodium Nitrate | 26 | 40 | 17 | 24 | 93 | 157 |
| " " Blood | 244 | 1,581 | 263 | ........ | 411 | ........ |
| " " Fish | 228 | 228 | ........ | ........ | 184 | ........ |
| " " Hair | 248 | 574 | 434 | 723 | 363 | ........ |
| " " Poudrette | 3,450 | 10,200 | 6,000 | 5,000 | ........ | ........ |
| " " Superphosphates, 30 to 40 per cent | 562 | ........ | ........ | ........ | ........ | ........ |
| " " Superphosphates, 11 to 18 per cent | 3,963 | 5,315 | ........ | ........ | ........ | ........ |
| " " Bone Black Superphosphate | ........ | ........ | 2,488 | 594 | 370 | 457 |
| " " S. C. Rock | ........ | ........ | 1,124 | 2,078 | 1,303 | 1,745 |
| Total | 30,163 | 46,664 | 37,810 | 38,678 | 31,216 | 33,633 |

*The total number of tons, in 1886 and 1888, under Ammonite, includes both blood and fish, returns having been made, in many cases, without discrimination.

THE AVERAGE RETAIL PRICES FOR 1882, 1884, 1885, 1886, 1887 AND 1888.

| | 1882. | 1884. | 1885. | 1886. | 1887. | 1888. |
|---|---|---|---|---|---|---|
| Complete Manure | $41 00 | $38 00 | $35 73 | $36 68 | $34 80 | $34 83 |
| Ammoniated Superphosphate without Potash (Dissolved Bone, &c.) | 32 00 | 31 00 | 31 62 | 29 25 | 32 63 | 31 90 |
| Ground Bone | 37 00 | 36 00 | 31 25 | 34 35 | 35 39 | 33 76 |
| Kainit | 12 00 | 10 00 | 11 75 | 10 60 | 10 25 | 12 83 |
| Muriate of Potash | 41 00 | 38 00 | 42 15 | 42 00 | 39 54 | 42 33 |
| Ammonite | 56 00 | 43 00 | 43 00 | †40 40 | ........ | †36 66 |
| Ammonium Sulphate | 99 00 | 70 50 | 68 50 | 70 00 | 68 20 | 69 70 |
| Sodium Nitrate | 76 00 | 54 00 | 52 25 | 58 72 | 51 61 | 52 00 |
| Blood | 56 00 | 43 50 | 38 67 | ........ | 35 33 | ........ |
| Fish | 45 00 | 31 50 | 34 66 | ........ | 35 17 | ........ |
| Hair | 10 00 | 11 00 | 10 00 | 10 00 | ........ | ........ |
| Poudrette | 10 00 | 10 00 | 10 00 | 10 00 | ........ | ........ |
| Superphosphates with 30 to 40 per cent. Phosphoric Acid | 75 00 | ........ | ........ | ........ | ........ | ........ |
| Superphosphates with 11 to 18 per cent. Phosphoric Acid | 28 50 | 24 50 | ........ | ........ | ........ | ........ |
| Superphosphates made from Bone Black | 34 00 | 26 00 | 29 86 | 25 85 | 26 95 | 24 80 |
| " " " S. C. Rock | 26 60 | 20 00 | 20 31 | 17 75 | 17 73 | 15 60 |

†The prices for blood, ammonite and fish have been averaged for the years 1886 and 1888, for reason mentioned above.

The table also shows that during the period from 1882 to 1887, with the exception of potash, the decline in the prices of the raw materials from which complete fertilizers are made, was even more marked, averaging 33 per cent. for nitrogenous materials and 27.5 per cent. for superphosphates. The record for 1888 shows that the prices of organic nitrogen and phosphoric acid were lower, and that potash and soluble nitrogen were higher than in 1887. The variation from 1887, however, was very slight, except in the case of kainit, the price of which increased 25 per cent., and South Carolina rock superphosphate, the price of which decreased 14 per cent.

The question has been raised whether this decline in the average prices of complete manures has been accompanied by a corresponding decrease in the absolute amounts of plant-food actually delivered to consumers. To answer this, the analyses made by the Station in past years have been averaged with the following results:

| | Total Nitrogen. Per cent. | Total Phos. Acid. Per cent. | Available Phos. Acid. Per cent. | Insoluble Phos Acid. Per cent. | Potash. Per cent. |
|---|---|---|---|---|---|
| 1888 average of 153 samples....... | 2.77 | 10.91 | 8.09 | 2.82 | 4.29 |
| 1887 " " 153 " ...... | 2.79 | 10.87 | 7.69 | 3.18 | 4.22 |
| 1886 " " 146 " ....... | 2.66 | 10.82 | 8.07 | 2.75 | 3.87 |
| 1885 " " 103 " ....... | 2.61 | 11.16 | 8.33 | 2.83 | 3.79 |

An examination of these figures indicates that no marked change in the average quality of fertilizers has occurred during the past four years. This is rendered more definite by computing cash valuations upon the basis of the Station's schedule for 1888.

On this basis a fertilizer to represent the average for each of the three years would be valued as follows:

| | | |
|---|---|---|
| 1888 ........................................ | $27 42 | per ton. |
| 1887........................................ | 26 99 | " |
| 1886........................................ | 26 63 | " |
| 1885........................................ | 26 85 | " |

*The decline in the prices of complete fertilizers, therefore, was not accompanied by a corresponding decrease in the absolute amounts of plant-food delivered to consumers.*

The total cash value of the reported sales of commercial fertilizers in this State during 1888, as compared with that of previous years, is as follows:

| | |
|---|---|
| Total value of fertilizers reported for 1882 | $1,070,113 00 |
| " " " " " " 1884 | 1,369,004 00 |
| " " " " " " 1885 | 1,116,670 00 |
| " " " " " " 1886 | 1,181,266 00 |
| " " " " " " 1887 | 1,022,434 00 |
| " " " " " " 1888 | 1,125,881 00 |

## II.

## THE COMMERCIAL RELATIONS OF FERTILIZERS.

1. *Their market prices.*
2. *The sources and quality of their nitrogen, phosphoric acid and potash.*
3. *Their guaranteed chemical composition and relative commercial values.*

### 1.

### THE MARKET PRICES OF FERTILIZERS.

The preceding records show that the farmers of this State paid at least $885,000 last season for complete manures. It is therefore a matter of importance to ascertain the principal conditions which influence the selling-prices of these materials.

Complete fertilizers are made by mixing a number of crude products, each of which contains one or more of the following elements of plant-food, viz.: Nitrogen, phosphoric acid and potash. Efforts have therefore been made to secure—

*The average wholesale prices of nitrogen, phosphoric acid and potash.*

*The average retail prices of nitrogen, phosphoric acid and potash.*

*The advance in prices between the wholesale and retail markets.*

The wholesale prices are quoted every Wednesday in the well-known trade journal, *The Oil, Paint and Drug Reporter.* These prices have been tabulated for the entire year, and have then been recalculated in order to express the results in the form adopted by the Experiment Stations of this country.

The retail prices were secured by the chemists of this Station, who visited all of the principal factories in which fertilizers are mixed;

sampled all crude products found, and learned from the owners the rates charged per ton for each of said products before they were mixed to form complete manures.

A comparison of the retail and wholesale prices, secured as above described, gives the following:

| | Average percentages by which the retail prices exceed the wholesale. | | |
|---|---|---|---|
| | 1886. | 1887. | 1888. |
| Nitrogen from Nitrate of Soda | 27.3 | 23.1 | 22.5 |
| " " Sulphate of Ammonia | 19.9 | 13.0 | 7.6 |
| " " Dried Blood | 40.8 | 26.2 | 6.0 |
| " " " Fish | ........ | ........ | ........ |
| " " Ammonite | 13.7 | 12.6 | 11.6 |
| Soluble Phosphoric Acid from Bone Black | ........ | ........ | ........ |
| " " " " S. C. Rock | 35.0 | 33.0 | 33.3 |
| Reverted " " " Bone Black | ........ | ........ | ........ |
| " " " " S. C. Rock | 35.0 | 33.0 | 33.3 |
| Insoluble " " " Bone Black | ........ | ........ | ........ |
| " " " " S. C. Rock | 38.7 | 33.0 | 33.3 |
| Potash from High-Grade Sulphate | ........ | ........ | ........ |
| " " Double Sulphates of Potash and Magnesia | 51.2 | 40.8 | 35.5 |
| " " Kainit | 44.8 | 29.0 | 34.2 |
| " " Muriate | 14.3 | 17.1 | 11.1 |

A summary of the above results shows that in 1888 the retail prices exceeded the wholesale by the following percentages: Nitrogen, 11.9 per cent.; available phosphoric acid, 33.3 per cent.; potash, 26.9 per cent. With the exception of nitrogen, the differences between the wholesale and retail rates for 1887 and 1888 are practically identical, and these differences have been very uniform since 1885, averaging 33.7 per cent. for phosphoric acid and 30 per cent. for potash. In

the case of nitrogen, fluctuations have been more apparent, the difference between wholesale and retail prices being 14.3 per cent. in 1885, 25.4 per cent. in 1886 and 11.9 per cent. in 1888. This comparison would seem to indicate a tendency on the part of the manufacturers to sell closer to the wholesale market in the case of nitrogen, while in the case of phosphoric acid and potash the limit was reached in 1886.

### SUMMARY.

RETAIL PRICES EXCEED WHOLESALE BY THE FOLLOWING PERCENTAGES.

| | 1885. | 1886. | 1887. | 1888. |
|---|---|---|---|---|
| Nitrogen | 14.3 | 25.4 | 19.7 | 11.9 |
| Available Phosphoric Acid | 52.0 | 35.0 | 33.0 | 33.3 |
| Potash | 36.2 | 36.2 | 29.0 | 26.9 |

The data upon which all of the above information depends will be found on the following pages.

### THE WHOLESALE PRICES OF PHOSPHORIC ACID, NITROGEN AND POTASH IN CRUDE PRODUCTS.

#### PHOSPHORIC ACID.

The wholesale prices of phosphoric acid remained unchanged throughout the years 1885, 1886 and 1887, at $12.00 to $15.00 per ton. These prices continued in 1888 until May, when wholesale quotations ruled at the rate of $10.50 to $11.20 per ton, and continued at that figure throughout the remainder of the year. The average analysis of seven samples examined at this Station is as follows:

| | | |
|---|---|---|
| Soluble Phosphoric Acid | 10.69 | per cent. |
| Reverted " " | 1.15 | " " |
| Insoluble " " | 3.15 | " " |

At the average price of $11.75 per ton of acid phosphate, the wholesale prices per pound of phosphoric acid rule as follows:

| | Cents. |
|---|---|
| Soluble | 4.65 |
| Reverted | 4.65 |
| Insoluble | 1.16 |

## NITROGEN AND POTASH.

### WHOLESALE PRICES IN NEW YORK, PER TON.

| Months. | Of Nitrogenous Matter. | | | | | | | | Of Potash Salts. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Nitrate of Soda. | | Sulphate of Ammonia. | | Azotine. | | Dried Blood. | | Muriate of Potash. | | Kainit. | | Double Sulphate of Potash and Magnesia. | |
| | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. |
| Jan ...... | $43 00 | $42 20 | $61 20 | $60 20 | $30 75 | $30 00 | $30 15 | $29 40 | $36 00 | $34 50 | $8 50 | $8 00 | $23 00 | $22 00 |
| Feb ...... | 44 00 | 41 00 | 63 80 | 62 80 | 31 95 | 31 05 | 32 10 | 31 05 | 36 20 | 34 50 | 8 50 | 8 10 | 21 20 | 22 50 |
| March .. | 44 20 | 38 00 | 67 50 | 61 00 | 33 75 | 33 00 | 33 00 | 32 25 | 35 50 | 34 50 | 11 25 | 8 75 | 23 20 | 22 50 |
| April.... | 41 80 | 39 00 | 67 50 | 67 00 | 33 75 | 33 00 | 33 00 | 32 25 | 36 00 | 34 50 | 11 50 | 8 75 | 23 50 | 22 50 |
| May ..... | 41 80 | 40 40 | 66 00 | 65 00 | 33 15 | 32 40 | 33 00 | 32 25 | 36 20 | 34 80 | 9 20 | 8 80 | 23 10 | 21 70 |
| June.... | 41 80 | 40 50 | 64 50 | 63 50 | 33 00 | 32 25 | 33 00 | 32 25 | 36 00 | 35 50 | 10 66 | 8 94 | 22 00 | 20 50 |
| July ..... | 41 60 | 40 00 | 64 00 | 63 00 | 34 65 | 33 38 | 34 65 | 33 37 | 36 00 | 35 20 | 11 37 | 9 32 | 22 00 | 21 50 |
| Aug...... | 42 00 | 40 80 | 64 00 | 63 00 | 35 25 | 34 50 | 35 25 | 34 50 | 36 00 | 35 00 | 10 25 | 9 25 | 21 50 | 21 00 |
| Sept...... | 43 20 | 41 50 | 64 00 | 63 00 | 35 25 | 34 50 | 35 63 | 34 87 | 36 50 | 36 00 | 10 23 | 9 50 | 22 80 | 22 00 |
| Oct ...... | 44 60 | 42 60 | 65 60 | 64 40 | 37 35 | 36 60 | 37 35 | 36 60 | 37 00 | 36 30 | 10 40 | 9 68 | 24 00 | 23 00 |
| Nov ..... | 46 20 | 44 80 | 69 00 | 68 00 | 39 75 | 38 25 | 38 25 | 37 50 | 37 00 | 36 50 | 10 50 | 9 75 | 24 00 | 23 00 |
| Dec ...... | 48 00 | 46 80 | 69 00 | 67 80 | 39 75 | 38 25 | 38 25 | 37 50 | 37 00 | 36 50 | 10 50 | 9 75 | 24 60 | 23 40 |

### WHOLESALE PRICES IN NEW YORK, PER POUND, OF PLANT FOOD.

| 1888. Months. | Wholesale cost, per pound, of nitrogen in form of— | | | | | | | | Wholesale cost, per pound, of potash in form of— | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Nitrate of Soda. | | Sulphate of Ammonia | | Azotine. | | Dried Blood. | | Muriate of Potash. | | Kainit. | | Double Sulphate of Potash and Magnesia. | |
| | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. |
| | cts | cts. | cts. | cts. | cts. | cts. | cts. | cts. | cts. | cts. | cts. | cts. | cts. | cts. |
| January.................... | 13.4 | 13.2 | 14.9 | 14.7 | 12.3 | 12.0 | 12.1 | 11.8 | 3.6 | 3.5 | 3.4 | 3.2 | 4.6 | 4.4 |
| February.... ............. | 13.8 | 12.8 | 15.5 | 15.3 | 12.8 | 12.4 | 12.8 | 12.4 | 3.6 | 3.5 | 3.4 | 3.2 | 4.8 | 4.5 |
| March ...................... | 13.8 | 11.9 | 16.5 | 14.9 | 13.5 | 13.2 | 13.2 | 12 9 | 3.6 | 3.5 | 4.5 | 3.5 | 4.6 | 4.5 |
| April......................... | 13.1 | 12.2 | 16.5 | 16.3 | 13.5 | 13.2 | 13.2 | 12.9 | 3.6 | 3.5 | 4.6 | 3.5 | 4.7 | 4.5 |
| May ......................... | 13.1 | 12.6 | 16.1 | 15.9 | 13.3 | 12.9 | 13.2 | 12.9 | 3.6 | 3.5 | 3.7 | 3.5 | 4.6 | 4.3 |
| June......................... | 13.1 | 12.6 | 15.7 | 15.5 | 13.2 | 12.9 | 13.2 | 12.9 | 3.6 | 3.5 | 4.3 | 3.6 | 4.4 | 4.1 |
| July .......................... | 13.0 | 12.5 | 15.6 | 15.4 | 13.9 | 13.4 | 13.9 | 13.4 | 3.6 | 3.5 | 4.5 | 3.7 | 4.4 | 4.3 |
| August ...................... | 13.1 | 12.8 | 15.6 | 15.4 | 14.1 | 13.8 | 14.1 | 13.8 | 3.6 | 3.5 | 4.1 | 3.7 | 4.3 | 4.2 |
| September .... .... ...... | 13.5 | 13.0 | 15.6 | 15.4 | 14.1 | 13.8 | 14.3 | 13.9 | 3.7 | 3.6 | 4.1 | 3.8 | 4.6 | 4.4 |
| October ..................... | 13.9 | 13.3 | 16.0 | 15.7 | 14.9 | 14.6 | 14.9 | 14.6 | 3.7 | 3.6 | 4.2 | 3.9 | 4.8 | 4.6 |
| November. ............... | 14.4 | 14.0 | 16.8 | 16.6 | 15.9 | 15.3 | 15.3 | 15.0 | 3,7 | 3.6 | 4.2 | 3.9 | 4.8 | 4.6 |
| December.................. | 15.0 | 14.6 | 16.8 | 16.5 | 15.9 | 15.3 | 15.3 | 15.0 | 3.7 | 3.6 | 4.2 | 3.9 | 4.9 | 4.7 |
| **Average for 1888..** | **13.3** | | **15.8** | | **13.8** | | **13.6** | | **3.6** | | **3.8** | | **4.5** | |
| **Average for 1887..** | **13.0** | | **14.6** | | **13.5** | | **13.0** | | **3.5** | | **3.1** | | **4.4** | |
| **Average for 1886..** | **14.3** | | **15.1** | | **14.6** | | **14.2** | | **3.5** | | **2.9** | | **4.3** | |

The above table indicates that the wholesale prices of the various forms of nitrogen and potash have been steadily increasing throughout the year. With the exception of nitrate of soda and double sulphate of potash and magnesia, the lowest points were reached in January, and, with the exception of kainit, the highest points were reached in December. The increase ranges for nitrogen from 13 per cent. in the case of nitrate of soda to 29 per cent. in azotine, and for potash from 2.8 per cent. in muriate of potash to 35 per cent. in kainit. The above table also gives the average wholesale prices for the past three years. A comparison shows that the price of potash, from all sources, has been greater in both 1887 and 1888 than in 1886; the greatest percentage increase being in kainit in 1888. In the case of nitrogen, however, there has been considerable fluctuation in price. The lowest prices for all forms were reached in 1887.

## AVERAGE RETAIL PRICES OF NITROGEN, PHOSPHORIC ACID AND POTASH IN CRUDE PRODUCTS.

From time to time, during the spring and summer, the Station's chemist visited, without warning, the principal factories from which this State's supplies of fertilizers are drawn. All material found was carefully sampled, and the retail cash prices were obtained by letter from the manufacturers. After an analysis of the samples, therefore, it was not difficult to calculate the retail prices per pound of the various forms of nitrogen, phosphoric acid and potash used in this trade.

The tables upon subsequent pages furnish in detail the information gained by this work, and afford data also for the following summary. For comparison, results secured in a similar manner in 1884, 1885, 1886 and 1887 are republished:

| | 1884. | 1885. | 1886. | 1887. | 1888. |
|---|---|---|---|---|---|
| | cts. | cts. | cts. | cts. | cts. |
| Cost per pound of Nitrogen from Nitrate of Soda | 16.9 | 16.1 | 18.2 | 16.0 | 16.3 |
| " " " " " " Sulphate of Ammonia | 17.1 | 16.7 | 18.1 | 16.5 | 17.0 |
| " " " " " " Dried Blood | 18.3 | 15.5 | 20.0 | 16.4 | 14.4 |
| " " " " " " Dried Fish | ........ | 14.8 | *16.6 | 15.2 | 15.3 |
| " " " " " " Ammonite and Tankage | 15.8 | 16.1 | ........ | †15.2 | †15.4 |
| " " " " Soluble Phosphoric Acid from Bone Black | 7.3 | 7.8 | 7.8 | 8.2 | 7.5 |
| " " " " " " " " S. C. Rock | 8.6 | 8.6 | 7.4 | 7.5 | 6.2 |
| " " " " Reverted " " " Bone Black | 6.7 | 6.9 | 7.8 | 8.2 | 7.5 |
| " " " " " " " " S. C. Rock | 7.8 | 7.6 | 7.4 | 7.5 | 6.2 |
| " " " " Insoluble " " " Bone Black | 2.9 | 1.7 | 1.9 | 2.0 | 1.9 |
| " " " " " " " " S. C. Rock | 1.9 | 1.9 | 1.9 | 1.9 | 1.5 |
| " " " " Potash from High-Grade Sulphate | ........ | 6.7 | 5.8 | 5.7 | 4.7 |
| " " " " " " Double Sulph. Potash & Magn'a, | 7.2 | 6.8 | 6.5 | 6.2 | 6.1 |
| " " " " " " Kainit | 4.5 | 4.5 | 4.2 | 4.0 | 5.1 |
| " " " " " " Muriate | 4.2 | 4.1 | 4.0 | 4.1 | 4.0 |

* This average also represents the retail cost of nitrogen in ammonite and castor pomace.
† Does not include tankage.

These averages are the *manufacturers' retail cash prices for the nitrogen, phosphoric acid and potash in the crude stock from which complete fertilizers are made.*

## COMPARISON BETWEEN THE AVERAGE WHOLESALE AND RETAIL PRICES OF NITROGEN, PHOSPHORIC ACID AND POTASH.

The conclusions reached in regard to the wholesale and retail prices are here tabulated. They represent the manufacturers' *wholesale* and *retail* prices for plant-food *in its best forms.* The percentages by which the retail prices exceed the wholesale, have been taken as the basis of the comparison :

| | Manufacturers' averages. | | | | Average percentage by which the retail prices exceed the wholesale. | | |
|---|---|---|---|---|---|---|---|
| | Wholesale prices for 1887. | Retail prices for 1887. | Wholesale prices for 1888. | Retail prices for 1888. | 1886. | 1887. | 1888. |
| | cts. | cts. | cts. | cts. | | | |
| Nitrogen from Nitrate of Soda | 13.0 | 16.0 | 13.3 | 16.3 | 27.3 | 23.1 | 22.5 |
| " " Sulphate of Ammonia | 14.6 | 16.5 | 15.8 | 17.0 | 19.9 | 13.0 | 7.6 |
| " " Dried Blood | 13.0 | 16.4 | 13.6 | 14.4 | 40.8 | 26.2 | 6.0 |
| " " " Fish | ........ | 15.2 | ........ | 15.3 | ........ | ........ | ........ |
| " " Ammonite | 13.5 | 15.2 | 13.8 | 15.4 | 13.7 | 12.6 | 11.6 |
| Soluble Phosphoric Acid from Bone Black | ........ | 8.2 | ........ | 7.5 | ........ | ........ | ........ |
| " " " " S. C. Rock | 5.64 | 7.5 | 4.7 | 6.2 | 35.0 | 33.0 | 33.3 |
| Reverted " " " Bone Black | ........ | 8.2 | ........ | 7.5 | ........ | ........ | ........ |
| " " " " S. C. Rock | 5.64 | 7.5 | 4.7 | 6.2 | 35.0 | 33.0 | 33.3 |
| Insoluble " " " Bone Black | ........ | 2.0 | ........ | 1.9 | ........ | ........ | ........ |
| " " " " S. C. Rock | 1 41 | 1.9 | 1.2 | 1 5 | 38.7 | 35.0 | 33.3 |
| Potash from High-Grade Sulphate | ........ | 5.7 | ........ | 4.7 | ........ | ........ | ........ |
| " " Double Sulphates of Potash and Magnesia | 4.4 | 6.2 | 4.5 | 6.1 | 51.2 | 40.8 | 35.5 |
| " " Kainit | 3.1 | 4.0 | 3.8 | 5.1 | 44.8 | 29.0 | 34.2 |
| " " Muriate | 3.5 | 4.1 | 3.6 | 4.0 | 14.3 | 17.1 | 11.1 |

## 2.

### THE SOURCES OF THE NITROGEN, PHOSPHORIC ACID AND POTASH FOUND IN COMPLETE FERTILIZERS.

As has been already stated, the chemists of this Station visit without warning nearly all of the factories in which this State's supplies of fertilizers are prepared. These visits are invariably made during the busiest season of the year, and an opportunity is thereby secured for inspecting and sampling crude stocks. In this manner reliable information is gained regarding the quality of the nitrogen, phosphoric acid and potash used by each manufacturer in his brands of complete manures.

### NITROGENOUS MATERIALS.

In the following tables these materials have been classified as soluble and as insoluble in water. In the first class may be found the *nitrates* and *ammonia salts;* in the second, the dried blood, dried fish, ammonite, tankage and other forms of organic nitrogen.

Difficulties were experienced in securing samples of dried blood. In many places tankage was offered as a substitute.

The following description regarding tankage is copied from the last annual report of this Station:

"The scraps and useless pieces of meat and bone are boiled and then subjected to hydraulic pressure, by which fat and water are removed. The cakes from the presses are then desiccated in revolving dryers, and afterwards ground. Some samples of the dried product analyze *four* per cent. ammonia and fifty to fifty-five per cent. bone phosphate of lime, and therefore are practically pure ground bone. Other samples analyze seven to eight per cent. of ammonia and from thirty to thirty-five per cent. bone phosphate of lime, indicating that considerable meat has been dried and ground with the bone."

Tankage is classified with ground bone, and in consequence its mechanical condition is a matter of considerable importance. A number of samples of it will be found in the proper table, in which it will be seen that care is now taken to grind it quite as fine as the market demands.

### PHOSPHORIC ACID.

The superphosphates have been arranged with reference to the crude stock from which they are made; those from bone black and bone ash being in the first table, and those from South Carolina rock and similar mineral phosphates, in the second.

No analyses of natural guanos are reported this year. The analysis of one sample of phosphate meal is tabulated under the head of miscellaneous samples. This product was subjected to field trials in 1887 by this Station in order to determine its agricultural value, and incidentally to determine its position in the trade. In these trials it proved to be less serviceable than precipitated phosphates, though relatively a cheap source of phosphoric acid. Business difficulties have arisen which prevented its sale in this State during the past year.

## POTASH SALTS.

The State law provides that in the analysis of fertilizers chemists shall determine only those forms of potash which dissolve in water; it ignores, therefore, greensand marl, and also certain forms of organic matter, both of which are sometimes used as sources of this element.

The "muriate," "kainit" and "double sulphate" are well-known salts from the German mines near Stassfurt. The two first mentioned are now frequently found in farmers' hands, but the high prices demanded for small lots at retail exclude the double sulphate from the trade.

A new product, known as the high-grade sulphate, has recently been introduced. It contains potash equivalent to 95 per cent. sulphate of potash, and, consequently, may prove very serviceable to manufacturers who wish to use nitrogenous matters or phosphates of low percentage composition in making up their standard fertilizers.

Cotton-hull ashes are also chiefly valuable for their potash, though often containing high percentages of available phosphoric acid.

An analysis of one sample is published this year. Care should be exercised in purchasing this article to secure a guaranteed analysis, since it is a waste product and great variations are likely to occur in its composition.

## FORMS OF NITROGEN

**Readily and Completely Soluble in Water.**

### NITRATE OF SODA

FURNISHING

**Nitrogen in Form of Nitrates.**

| Station Number. | NAME AND ADDRESS OF DEALER. | Percentage of Nitrogen. | Cost of Nitrogen per lb. | Cost of 2,000 lbs. of Nitrate of Soda. |
|---|---|---|---|---|
| | | | cts. | |
| 2140 | J. J. Allen's Sons. Philadelphia | 16.12 | 14.9 | $48 00 |
| 2172 | Lister's A. C. Works, Newark | 16.06 | 14.9 | 48 00 |
| 2215 | Read & Co., New York | 16.02 | 20.3 | 65 00 |
| 2230 | Geo. B. Forrester, New York | 15.96 | 15.0 | 48 00 |
| 2237 | H. J. Baker & Bro., New York | 15.79 | 15.8 | 50 00 |
| 2257 | Bowker Fertilizer Co., New York | 16.01 | 16.4 | 52 50 |
| 2387 | Baugh & Sons Co., Philadelphia | 16.02 | 17.1 | 55 00 |
| 2404 | M. L. Shoemaker & Co., Philadelphia | 15.95 | 15.6 | 50 00 |
| | Average Cost per Pound of Nitrogen in Nitrate of Soda | | 16.25 | ............ |

### SULPHATE OF AMMONIA

FURNISHING

**Nitrogen in Form of Ammonia.**

| Station Number. | NAME AND ADDRESS OF DEALER. | Percentage of Nitrogen. | Cost of Nitrogen per lb. | Cost of 2,000 lbs. of Sulphate of Ammonia. |
|---|---|---|---|---|
| | | | cts. | |
| 2141 | J. J. Allen's Sons, Philadelphia | 21.09 | 14.7 | $62 00 |
| 2173 | Lister's A. C. Works, Newark | 20.46 | 17.1 | 70 00 |
| 2206 | Moller & Co., Maspeth, L. I. | 18.79 | 17.3 | 65 00 |
| 2209 | C. Meyer, Jr., Maspeth, L. I. | 20.32 | 17.8 | 72 50 |
| 2231 | Geo. B. Forrester, New York | 20.72 | 16.9 | 70 00 |
| 2238 | H. J. Baker & Bro., New York, | 20.45 | 17.1 | 70 00 |
| 2258 | Bowker Fertilizer Co., New York | 20.96 | 17.3 | 72 50 |
| 2388 | Baugh & Sons Co., Philadelphia | 20.49 | 18.3 | 75 00 |
| 2405 | M. L. Shoemaker & Co., Philadelphia | 20.60 | 17.0 | 70 00 |
| | Average Cost per Pound of Nitrogen in Sulphate of Ammonia | | 17.0 | ............ |

## FORMS OF NITROGEN INSOLUBLE IN WATER.

**Dried Blood, Dried Fish, Ammonite and Tankage**

FURNISHING

**Nitrogen in Form of Organic Matter.**

### DRIED BLOOD.

| Station Number. | NAME AND ADDRESS OF DEALER. | Percentage of Nitrogen. | Cost of Nitrogen per lb. | Cost of 2,000 lbs. of Dried Blood. |
|---|---|---|---|---|
| | | | cts. | |
| 2216 | Read & Co., New York | 13.35 | 14.1 | $37 50 |
| 2406 | M. L. Shoemaker & Co., Philadelphia | 13.62 | 14.7 | 40 00 |
| | **Average Cost per Pound of Nitrogen in Dried Blood** | | **14.4** | ...... |

### DRIED FISH.

| Station Number. | NAME AND ADDRESS OF DEALER. | Percentage. Nitrogen. | Phosphoric Acid. Soluble in Water. | Phosphoric Acid. Soluble in Ammonium Citrate. | Phosphoric Acid. Insoluble. | Phosphoric Acid. Available Found. | Cost per Pound. Nitrogen. | Phos. Acid. Soluble in Water. | Phos. Acid. Soluble in Ammonium Citrate | Phos. Acid. Insoluble. | Cost of 2,000 pounds of Fertilizer. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | cts. | cts. | cts. | cts. | |
| 2210 | C. Meyer, Jr., Maspeth, L. I. | 6.86 | 0.80 | 2.96 | 4.52 | 3.76 | 16.2 | 8 | 8 | 2 | $30 00 |
| 2376 | Lord & Polk, Odessa, Del. | 6.04 | 0.76 | 2.76 | 2.34 | 3.52 | 19.4 | 8 | 8 | 2 | *30 00 |
| 2261 | Bowker Fertilizer Co., N. Y. | 8.66 | 0.96 | 3.60 | 2.91 | 4.56 | 15.3 | 8 | 8 | 2 | 35 00 |
| 2455 | L. Fisher, Port Monmouth, N. J. | 8.61 | 0.74 | 3.46 | 2.20 | 4.20 | 13.0 | 8 | 8 | 2 | †30 00 |
| 2337 | Kirby & Smith, Woodbury, N. J. | 10.56 | 0.61 | 0.25 | 0.21 | 0.86 | 12.8 | 8 | 8 | 2 | †28 50 |
| 2522 | Sharpless & Carpenter, Phila. | 8.94 | 0.82 | 2.35 | 3.44 | 3.17 | 15.4 | 8 | 8 | 2 | *34 00 |
| | **Average Cost per Pound of Nitrogen in Dried Fish** | | | | | | **15.3** | ...... | ...... | ...... | ...... |

* Retail at Hammonton, N. J. † Unground but dry, and in good condition.

### AMMONITE AND CASTOR POMACE.

| Station Number. | NAME AND ADDRESS OF DEALER. | Percentage. Nitrogen. | Percentage. Phosphoric Acid. | Cost per Pound. Nitrogen. | Cost per Pound. Phosphoric Acid. | Cost of 2,000 lbs. of Fertilizer. |
|---|---|---|---|---|---|---|
| | | | | cts. | cts. | |
| 2214 | C. Meyer, Jr. | 8.29 | 3.08 | 14.7 | 6 | $28 00 |
| 2223 | Read & Co., Castor Pomace | 6.12 | 2.01 | 12.7 | 6 | 18 00 |
| 2239 | H. J. Baker & Bro., Castor Pomace | 5.96 | 2.05 | 14.7 | 6 | 20 00 |
| 2389 | Baugh & Sons Co., A. A. Nitrogen | 10.69 | 4.73 | 16.1 | 6 | 40 00 |
| 2407 | M. L. Shoemaker & Co., Ammonite "B" | 12.36 | 3.01 | 14.7 | 6 | 40 00 |
| | **Average Cost per Pound of Nitrogen** | | | **14.6** | ...... | ...... |

## FORMS OF NITROGEN INSOLUBLE IN WATER.

**Dried Blood, Dried Fish, Ammonite and Tankage**

FURNISHING

**Nitrogen in Form of Organic Matter.**

**TANKAGE AND SWIFT-SURE GUANO.**

| Station Number. | NAME AND ADDRESS OF DEALER. | Mechanical Analysis. | | | | Chemical Analysis. | | Selling Price at Factory of 2,000 pounds. |
|---|---|---|---|---|---|---|---|---|
| | | Finer than 1/50 inch. | Finer than 1/25 inch. | Finer than 1/12 inch. | Finer than 1/6 inch. | Nitrogen. | Phosphoric Acid. | |
| 2221 | Read & Co., New York | 41.0 | 27.0 | 20.0 | 12.0 | 6.59 | 11.82 | $25 00 |
| 2222 | " " " " | 35.0 | 27.0 | 24.0 | 14.0 | 5.57 | 12.95 | 28 00 |
| 2390 | Baugh & Sons Co., Philadelphia | 39.0 | 27.0 | 22.0 | 12.0 | 6.61 | 10.87 | 26 00 |
| 2408 | M. L. Shoemaker & Co., Philadelphia | 67.0 | 27.0 | 6.0 | ........ | 7.20 | 10.35 | 27 00 |
| 2509 | John Bowers & Co., Philadelphia | 38.0 | 32.0 | 11.0 | 19.0 | 8.05 | 9.98 | *25 00 |

* Retail price at Germania, N. J.

| Station Number. | NAME AND ADDRESS OF DEALER. | Cost of Phosphoric Acid per Pound in— | | | | Cost of Nitrogen per Pound in— | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Finer than 1/50 inch. | Finer than 1/25 inch. | Finer than 1/12 inch. | Finer than 1/6 inch. | Finer than 1/50 inch. | Finer than 1/25 inch. | Finer than 1/12 inch. | Finer than 1/6 inch. |
| 2221 | Read & Co., Tankage | 5.5 | 4.7 | 3.9 | 3.2 | 13.0 | 10.2 | 8.3 | 6.7 |
| 2222 | " " Ground Tankage | 6.7 | 5.7 | 4.8 | 3.8 | 15.7 | 12.4 | 10.0 | 8.1 |
| 2390 | Baugh & Sons Co., Tankage | 6.0 | 5.1 | 4.3 | 3.4 | 14.1 | 11.1 | 9.0 | 7.3 |
| 2408 | M. L. Shoemaker & Co., Swift-Sure Guano | 5.3 | 4.6 | 3.8 | 3.0 | 12.5 | 9.9 | 8.1 | 6.4 |
| 2509 | John Bowers & Co., "Blood" Tankage | 5.3 | 4.6 | 3.8 | 3.0 | 12.5 | 9.9 | 8.0 | 6.4 |
| | **Average Cost per Pound** | **5.8** | **5.0** | **4.1** | **3.3** | **13.6** | **10.7** | **8.6** | **7.0** |
| | Station's Prices | 7.0 | 6.0 | 5.0 | 4.0 | 16.5 | 13.0 | 10.5 | 8.5 |

## PLAIN SUPERPHOSPHATES

**Furnishing Soluble, Reverted and Insoluble Phosphoric Acid.**

MANUFACTURED FROM

**BONE BLACK, BONE ASH, ETC., ETC.**

| Station Number. | NAME AND ADDRESS OF MANUFACTURER. | Phosphoric Acid. | | | | | Cost per Pound. | | | Cost of 2,000 Pounds of Fertilizer. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Available. | | Phos. Acid. | | | |
| | | Soluble in Water. | Soluble in Ammonium Citrate. | Insoluble. | Found. | Guaranteed. | Soluble in Water. | Soluble in Ammonium Citrate. | Insoluble. | |
| 2144 | J. J. Allen's Sons, Philadelphia... | 16.03 | 0.19 | 0.28 | 16.22 | ......... | 5.84 | 5.84 | 1.46 | $19 00 |
| 2181 | Lister's A. C. Works, Newark...... | 17.70 | 0.66 | 0.36 | 18.36 | ......... | 7.04 | 7.04 | 1.76 | 26 00 |
| 2213 | C. Meyer, Jr., Maspeth, L. I......... | 16.23 | 0.30 | 0.38 | 16.53 | ......... | 7.52 | 7.52 | 1.88 | 25 00 |
| 2235 | Geo. B. Forrester, New York....... | 16.92 | ......... | 0.20 | 16.92 | ......... | 7.65 | 7.65 | 1.91 | 26 00 |
| 2245 | H. J. Baker & Bro , New York.... | 17.80 | ......... | 0.07 | 17.80 | ......... | 7.52 | 7.52 | 1.88 | 27 00 |
| 2246 | " " " " " | 40.95 | 3.40 | 1.40 | 44.35 | ......... | 8.04 | 8.04 | 2.01 | 72 00 |
| 2268 | Bowker Fertilizer Co., New York. | 16.00 | 1.20 | 0.44 | 17.20 | ......... | 7.52 | 7.52 | 1.88 | 26 00 |
| 2394 | Baugh & Sons Co , Phila............. | 15.99 | 0.13 | 0.04 | 16.12 | ......... | 8.04 | 8.04 | 2.01 | 26 00 |
| 2413 | M. L. Shoemaker & Co., Phila.... | 12.14 | 1.04 | 4.60 | 13.18 | ......... | 8.00 | 8.00 | 2.00 | 23 00 |
| 2414 | " " " " | 16.04 | 0.16 | 0.09 | 16.20 | ......... | 7.72 | 7.72 | 1.93 | 25 00 |
| | **Average Cost per Pound of Phos. Acid from Bone Black....** | | | | | | 7.48 | 7.48 | 1.87 | ........ |

| Station Number. | BRAND. | MANUFACTURER OR WHOLESALER. | SAMPLED BY |
|---|---|---|---|
| 2144 | Bone Black Superphosphate.. | J. J. Allen's Sons, Philadelphia . | I. W. Nicholson, Camden. |
| 2181 | " " " | Lister's A. C. Works, Newark...... | Assistant Chemist of Station.. |
| 2213 | " " " | C. Meyer, Jr., Maspeth, L. I......... | " " " " |
| 2235 | " " " | Geo. B. Forrester, New York....... | " " " " |
| 2245 | " " " | H. J. Baker & Bro., New York...... | " " " " |
| 2246 | High-Grade Superphosphate. | " " " " " ...... | " " " " |
| 2268 | Bone Black Superphosphate.. | Bowker Fertilizer Co , New York. | " " " " |
| 2394 | " " " | Baugh & Sons Co., Phila............. | " " " " |
| 2413 | Dissolved Bone Ash.............. | M. L. Shoemaker & Co., Phila.... | " " " " |
| 2414 | Bone Black Superphosphate.. | " " " " .... | " " " " |

## PLAIN SUPERPHOSPHATES

**Furnishing Soluble, Reverted and Insoluble Phosphoric Acid.**

MANUFACTURED FROM

**SOUTH CAROLINA ROCK AND OTHER MINERAL PHOSPHATES.**

| Station Number. | NAME AND ADDRESS OF MANUFACTURER. | Phosphoric Acid. Soluble in Water. | Soluble in Ammonium Citrate. | Insoluble. | Available. Found. | Available. Guaranteed. | Cost per Pound. Phos. Acid. Soluble in Water. | Soluble in Ammonium Citrate. | Insoluble. | Cost of 2,000 Pounds of Fertilizer. |
|---|---|---|---|---|---|---|---|---|---|---|
| 2143 | J. J. Allen's Sons, Philadelphia... | 10 32 | 1.64 | 2.18 | 11.96 | ......... | 5.00 | 5.00 | 1.25 | $12 50 |
| 2219 | Read & Co., New York ............... | 10.92 | 1.10 | 3.18 | 12.02 | ......... | 4.88 | 4.88 | 1.22 | 12 50 |
| 2243 | H. J. Baker & Bro., New York.... | 11.66 | 1.21 | 3.44 | 12.87 | ......... | 5.84 | 5.84 | 1.46 | 16 00 |
| 2267 | Bowker Fertilizer Co., New York. | 11.61 | 0.24 | 3.12 | 11.85 | ......... | 7.12 | 7.12 | 1.78 | 18 00 |
| 2393 | Baugh & Sons Co., Philadelphia.. | 9.48 | 1.74 | 3.62 | 11.22 | ......... | 6.60 | 6.60 | 1.65 | 16 00 |
| 2412 | M. L. Shoemaker & Co., Phila ... | 9.78 | 1.09 | 3.09 | 10 87 | ......... | 6.88 | 6.88 | 1.72 | 16 00 |
| 2478 | J. Richmond, Philadelphia ........ | 11.07 | 1.04 | 3.43 | 12.11 | ......... | 6.92 | 6.92 | 1.73 | 18 00 |
| **Average Cost per Pound of Phos. Acid from S. C. Rock........** | | | | | | | 6.16 | 6.16 | 1.54 | ......... |
| 2355 | Carteret Chem. Co., New York, Precipitated Phos. of Lime. | ......... | 22.33 | 0.06 | 22.30 | ......... | ......... | 4.48 | 1.12 | 20 00 |

| Station Number. | BRAND. | MANUFACTURER OR WHOLESALER. | SAMPLED BY. |
|---|---|---|---|
| 2143 | S. C. Rock Superphosphate... | J. J. Allen's Sons, Philadelphia.. | I. W. Nicholson, Camden. |
| 2219 | " " " " ... | Read & Co., New York............... | Assistant Chemist of Station |
| 2243 | " " " " ... | H. J. Baker & Bro., New York.... | " " " " |
| 2267 | " " " " ... | Bowker Fertilizer Co., New York. | " " " " |
| 2393 | " " " " ... | Baugh & Sons Co., Philadelphia. | " " " " |
| 2412 | " " " " ... | M. L. Shoemaker & Co., Phila .... | " " " " |
| 2478 | " " " " ... | J. Richmond, Philadelphia........ | " " " " |
| 2355 | Precipitated Phos. of Lime... | Carteret Chem. Co., New York.... | " " " " |

## GERMAN POTASH SALTS

**Readily Soluble in Distilled Water.**

### MURIATE OF POTASH.

| Station Number. | NAME AND ADDRESS OF DEALER. | Percentage of Potash. | Cost of Potash per Pound. | Cost of 2,000 lbs. of Muriate. |
|---|---|---|---|---|
| | | | cts. | |
| 2142 | J. J. Allen's Sons, Philadelphia | 53.34 | 3.9 | $42 00 |
| 2178 | Lister's A. C. Works, Newark | 53.64 | 3.7 | 39 50 |
| 2207 | Moller & Co., Maspeth, L. I. | 52.87 | 4.3 | 45 00 |
| 2211 | C. Meyer, Jr., Maspeth, L. I. | 52.50 | 3.8 | 40 00 |
| 2218 | Read & Co., New York | 55.51 | 3.9 | 43 00 |
| 2232 | Geo. B. Forrester, New York | 53.05 | 3.7 | 39 50 |
| 2241 | H. J. Baker & Bro., New York | 51.98 | 4.0 | *39 50 |
| 2263 | Bowker Fertilizer Co., New York | 51.06 | 4.2 | 42 50 |
| 2305 | Mapes' F. & P. Guano Co., New York | 55.31 | 4.1 | †46 00 |
| 2392 | Baugh & Sons Co., Philadelphia | 53.14 | 4.7 | 50 00 |
| 2410 | M. L. Shoemaker & Co., Philadelphia | 53.79 | 4.0 | *40 00 |
| 2411 | " " " " | 54.83 | 3.7 | ‡41 00 |
| | **Average Cost per Pound of Potash in Muriate** | | 4.0 | ........... |

* On basis of 80 per cent. muriate.
† Retail price at Cranbury.
‡ On basis of 88 per cent. muriate.

### KAINIT.

| Station Number. | NAME AND ADDRESS OF DEALER. | Percentage of Potash. | Cost of Potash per Pound. | Cost of 2,000 lbs. of Kainit. |
|---|---|---|---|---|
| | | | cts. | |
| 2177 | Lister's A. C. Works, Newark | 12.47 | 4.8 | $12 00 |
| 2217 | Reed & Co., New York | 13.13 | 4.6 | 12 00 |
| 2240 | H. J. Baker & Bro., New York | 12.67 | 5.1 | 13 00 |
| 2266 | Bowker Fertilizer Co., New York | 12.77 | 5.5 | 14 00 |
| 2391 | Baugh & Sons Co., Philadelphia | 11.80 | 5.5 | 13 00 |
| 2409 | M. L. Shoemaker & Co., Philadelphia | 12.73 | 5.1 | 13 00 |
| | **Average Cost per Pound of Potash in Kainit** | | 5.1 | ........... |

## POTASH SALTS.

**Double Sulphates of Potash and Magnesia.**

| Station Number. | NAME AND ADDRESS OF DEALER. | Percentage of Potash. | Cost of Potash per Pound. | Cost of 2,000 lbs. of the Double Sulphate. |
|---|---|---|---|---|
| | | | cts. | |
| 2179 | Lister's A. C. Works, Newark | 25.50 | 6.1 | $31 00 |
| 2212 | C. Meyer, Jr., Maspeth, L. I. | 26.05 | 5.8 | 30 00 |
| 2233 | Geo. B. Forrester, New York | 25.96 | 6.0 | 31 00 |
| 2242 | H. J. Baker & Bro., New York | 26.13 | 6.7 | 35 00 |
| 2265 | Bowker Fertilizer Co., New York | 26.35 | 5.7 | 30 00 |
| | **Average Cost per Pound of Potash** | | 6.1 | ............ |

**HIGH-GRADE**

**Sulphate of Potash.**

| Station Number. | NAME AND ADDRESS OF DEALER. | Percentage of Potash. | Cost of Potash per Pound. | Cost of 2,000 lbs. of the High-Grade Sulphate. |
|---|---|---|---|---|
| | | | cts | |
| 2234 | Geo. B. Forrester, New York | 47.92 | 4.6 | $44 00 |
| 2264 | Bowker Fertilizer Co., New York | 52.63 | 4.8 | 50 00 |
| | **Average Cost per Pound of Potash** | | 4.7 | ............ |

3.

THE GUARANTEED CHEMICAL COMPOSITION AND RELATIVE COMMERCIAL VALUES OF MERCHANTABLE FERTILIZERS.

An Act to regulate the manufacture and sale of fertilizers.

[Laws of New Jersey for 1874, page 90.]

1. That every commercial fertilizer which shall be offered for sale in this state shall be accompanied by an analysis, stating the percentage therein of ammonia, or its equivalent of nitrogen; of potash, in

any form or combination, soluble in distilled water; and of phosphoric acid in any form or combination; the portion of phosphoric acid soluble in distilled water; that portion soluble in a neutral solution of citrate of ammonia at a temperature not exceeding one hundred degrees Fahrenheit; and that portion of phosphoric acid not soluble in either of the above-named fluids, shall each be determined separately; and the material from which the phosphoric acid is obtained shall also be stated; a legible statement of such analysis shall accompany all packages or lots of over one hundred pounds sold, offered or exposed for sale.

5. That any person selling, offering or exposing for sale any commercial fertilizer without the analysis required by the first section of this act, or the act to which this act is a supplement, or with an analysis stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, shall forfeit fifty dollars for the first offense and one hundred dollars for each subsequent offense; *provided further*, that the provisions of this section, or the act to which this act is a supplement, shall not apply to any manure sold at a price not exceeding one-half a cent per pound, nor to any imported guanos.

### THE GUARANTEED CHEMICAL COMPOSITION OF FERTILIZERS.

From the Station's standpoint this subject involves—

1st. The sampling.
2d. The laboratory work.

Previous to the year 1884 all samples of fertilizers analyzed in this laboratory were drawn either by the Station's officials or by reputable farmers who had reasons for suspecting the quality of the brands bought for their own use. This system had many disadvantages and has been abandoned. At present the only samples received for analysis are those taken by duly-authorized Inspectors.

This plan has been satisfactory to both consumers and producers, for the Inspectors are, without exception, farmers of the highest standing, who undertake the work solely because it is regarded as a matter of vital interest to the farming community.

The names of those who have represented this Station during the past season are as follows:

| | | |
|---|---|---|
| CHARLES KRAUS | Egg Harbor City | Atlantic county. |
| JACOB B. ECKERSON | River Vale | Bergen county. |
| CALEB S. RIDGWAY | Columbus | Burlington county. |
| I. W. NICHOLSON | Camden | Camden county. |
| J. H. RICHARDSON | Rio Grande | Cape May county. |
| THEO. F. BAKER | Bridgeton | Cumberland county. |
| WM. R. WARD | Newark | Essex county. |
| JAS C. GRISCOM | Woodbury | Gloucester county. |
| AARON J. THOMPSON. | Readington | Hunterdon county. |
| FRANKLIN DYE | Trenton | Mercer county. |
| J. M. WHITE | New Brunswick | Middlesex county. |
| J. H. DENISE | Freehold | Monmouth county. |
| J. J. MITCHELL | Whippany | Morris county. |
| GEO A. MACBEAN | Lakewood | Ocean county. |
| JOHN GRUNDY | Paterson | Passaic county. |
| WOODNUTT PETTIT | Salem | Salem county. |
| J. S. TEN EYCK | North Branch | Somerset county. |
| D. R. WARBASSE | Hunt's Mills | Sussex county. |
| DENNIS C. CRANE | Roselle | Union county. |
| SAMUEL J. HIXSON | Bridgeville | Warren county. |

At the beginning of the season, each Inspector was furnished with a sampling tube, blanks for describing samples, bottle labels, &c., together with printed instructions regarding their uses, and each Inspector was requested to secure a sample of every brand of complete fertilizer which he could find in his district. As fast as samples were found they were shipped to New Brunswick, where they were properly numbered and stored.

A copy of the instructions, under which all samples were taken, is as follows:

DIRECTIONS TO BE OBSERVED IN SAMPLING FERTILIZERS.

Inspectors may sample fertilizers found either—

*First*—Upon farms;
*Second*—In dealers' storehouses; or,
*Third*—In manufactories.

The Station prefers that samples should be drawn either upon farms or in dealers' storehouses.

In sampling fertilizers found upon farms, Inspectors should ascertain—

*First*—That the farmer has received these fertilizers *during the present season.*

*Second*—That they were received in good condition, and have since been so stored that a noticeable gain or loss of moisture has been prevented.

*In no case should farm samples be taken from stock of a past season or from stock which is or has been carelessly stored.*

In sampling from *dealers' storehouses*, Inspectors should also ascertain whether the fertilizers are of old (last season's) or of new stock. Preference should always be given to the present season's goods. Circumstances may, however, make it advisable to sample old stock; in such cases, this fact should be distinctly stated by the Inspector, in his report to the Station's Director.

If for any reason it is found to be necessary to draw samples at factories, Inspectors should decline—

*First*—To sample from piles of fertilizers;

*Second*—To sample from bags which are not distinctly marked with the brand, the manufacturer's name and the guaranteed analysis.

If fertilizers are found stored in piles only, Inspectors should cause six or more bags to be filled from different portions of the piles; from these bags the samples may be drawn in the usual manner.

### SAMPLING.

Whenever the mechanical condition will allow, samples should be drawn by means of the *sampling tube*.

This tube is formed to a sharp point at one end, and can be forced to the bottom of a bag or barrel. A slot extending nearly its entire length can then be opened and the tube allowed to fill with the fertilizer. When the slot is closed and the tube withdrawn, it will contain a fair sample of any given package.

It is not desirable to sample lots of less than one-half ton of any one brand. In such lots portions may be taken from each bag; in larger lots each fifth or tenth bag may be opened. The several portions representing the same brand should then be carefully mixed and a quart fruit-jar filled, securely closed and marked with labels furnished by the Station.

As soon as a sample has been taken, and *invariably* before bags of another brand have been opened, the Inspector should carefully fill out the blank describing samples.

He should copy *from the bags*—

*First*—The brand;

*Second*—The name of the manufacturer;

*Third*—The guaranteed analysis.

Any other information desired can be sought from the owner of the fertilizer.

Each sample bottle should be carefully wrapped in heavy paper, and packed for transportation in a wooden box, properly closed. This box should be forwarded by express, directed to

THE NEW JERSEY AGRICULTURAL EXPERIMENT STATION,

GEO. H. COOK, *Director*,
New Brunswick, N. J.

## LABORATORY METHODS.

The methods followed in this laboratory have been developing gradually ever since the Station was organized; very slight modifications only have been introduced during the past year.

Each spring a circular letter is addressed to the fertilizer manufacturers, requesting a list of all brands intended for the New Jersey trade. The returns are properly classified and arranged in such a manner that brands which Inspectors fail to find are known, and special searches for them can then be instituted promptly.

As above stated, Inspectors are requested to sample all fertilizers offered for sale in their counties; many duplicates are consequently received at New Brunswick, all of which are numbered, however, and an entry is made for each in an appropriate book, one page of which is here published as an illustration. The manufacturer's name is withheld and letters are substituted for the names of brands, but in other respects the copy is strictly accurate. (See table, page 50.)

This firm offered fourteen different brands to the New Jersey trade, two of which, viz., A and K, seem to be extremely popular, for eleven samples of one and ten samples of the other indicate a wide distribution throughout this State. It will be noticed that one number only opposite each brand is printed in black-faced type. This indicates the particular sample of that brand which was selected for analysis. These entries show that the analyses representing this firm were upon samples drawn from twelve different counties.

The section of the Fertilizer law published as an introduction to this chapter indicates that certain analyses must be made in this State according to prescribed methods; all others are left to the judgment of the chemists.

The rules of this laboratory require that all determinations shall be made in duplicate, and that duplicates shall not be made upon the same day. In the case of total nitrogen and total phosphoric acid, the duplicate determinations are also made in each case by two radically different methods.

## GUARANTEES.

With two exceptions, every manufacturer has observed the State law, which provides that the percentages of nitrogen, of phosphoric acid and of soluble potash, which are claimed to be present in a

| Manufacturer. | Brand. | Charles Kraus, Atlantic Co. | Jacob B. Eckerson, Bergen Co. | Caleb S. Ridgway, Burlington Co. | I. W. Nicholson, Camden Co. | J. H. Richardson, Cape May Co. | Theodore F. Baker, Cumberland Co. | William R. Ward, Essex Co. | James C. Griscom, Gloucester Co. | Hudson Co. | Aaron J. Thompson, Hunterdon Co. | Franklin Dye, Mercer Co. | J. M. White, Middlesex Co. | J. H. Denise, Monmouth Co. | J. J. Mitchell, Morris Co. | Geo. A. MacBean, Ocean Co. | John Grundy, Passaic Co. | Woodnutt Pettit, Salem Co. | J. S. Ten Eyck, Somerset Co. | D. R. Warbasse, Sussex Co. | Dennis C. Crane, Union Co. | Samuel J. Hixson, Warren Co. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SAMPLED BY. | | | | | | | | | | | | | | | | | | | | | |
| | A | 2514 | 2467 | | 2375 | | | | 2535 | | | | 2159 | 2146 | | 2296 | 2501 | 2309 | 2651 | | 2347 | |
| | B | 2518 | | | | | | 2536 | | | | | | | | 2456 | 2506 | | | | | |
| | C | | | | | | | 2537 | | | | | | | | | 2504 | | | | | |
| | D | 2516 | 2469 | | | | | 2539 | | | | | | | | | 2505 | | | | | |
| | E | | | | | | | | | | | | | | | | | | | | | |
| | F | | | | | | | | | | | | | | | | | | | | | |
| | G | 2515 | | | | | | | | | | | 2157 | | | | 2502 | | | | 2349 | |
| | H | | | | | | | | | | 2675 | | | | | | | | | | | |
| | I | | | | | | | | | | | | | | | 2298 | | | | | | |
| | J | | | | | | | | | | | | | 2673 | | 2297 | | | | | 2346 | |
| | K | 2517 | 2471 | | | | | 2534 | | | 2547 | | | | | 2295 | 2503 | 2311 | 2649 | | 2348 | 2557 |
| | L | | | | | | | | | | | | | | | | | | 2650 | | | |
| | M | | | | | | | | | | | | | | | | | | | | | |
| | N | | | | | | | | | | | | | | | | | | | | | |
| | O | | | | | | | | | | | | | | | | | | | | | |
| | P | | | | | | | | | | | | 2304 | | | | | | | | | |
| | Q | | | | | | | | | | | | | | | | | | | | | |
| | R | | | | 2419 | | | | | | | | | | | | | | | | | |
| | S | | | | | | 2535 | | | | | | | | | | | | | | | |
| | T | | | | | | 2538 | | | | | | | | | | | 2314 | | | | |

brand, shall be distinctly printed upon every package of fertilizer exposed for sale.

In the one case the manufacturer claimed that a few goods were ordered before he could secure his stencil plates, and that it was his intention to obey the law in this respect. In the other case, no analysis was printed on the bags, the dealer claiming that an analysis of the goods published in pamphlet form was all that was furnished by the manufacturer. In the pamphlet accompanying the sample the date of analysis had been erased; the testimonials, however, were dated 1858 and 1860. Efforts to find the responsible manufacturers of this brand have thus far been unavailing.

In all cases the Station's analyses of brands are compared with their manufacturers' guarantees; in this report prominence is given to the comparison by the use of black-faced type. Out of 170 samples, 96 have been found to contain more plant-food of all kinds than their manufacturers claim, while 4 fall below their guarantees in every respect. Fifty-six per cent., therefore, of the samples tested are up to the standard, and 2.5 per cent. are, in all respects, below grade. These results are practically identical with those secured in 1885, 1886 and 1887.

Of the remaining samples, 70 in number, some contain excessive amounts of one or more elements, and fall below their claims in other respects, indicating careless work in the factories. Others show that the State law which regulates the method of analyzing fertilizers has been ignored, but in no case has proof been secured of a deliberate attempt to defraud.

Of the three cases deemed decidedly suspicious, two were evidently due to ignorance, since extraordinary claims were made for chemical elements that are not recognized as having any agricultural value. These brands, when analyzed by the Station, have been published, with such comments as were deemed necessary to guide farmers in their purchases.

The condition of the fertilizer trade in New Jersey during the past year shows no marked improvement over that of 1887. On the whole, however, a decided tendency is shown on the part of the manufacturers to conform to the law and to place their product on the market in a good mechanical condition.

During the past year four bulletins containing fertilizer analyses have been published:

No. XLV. Devoted to Prices of Nitrogen, Phosphoric Acid and Potash, for 1888.
" XLVII. " " Fertilizer Supplies
" XLVIII. " " Complete Fertilizers.
" XLIX. " " Complete Fertilizers, Ground Bone and Miscellaneous Fertilizers.

The circulation of these publications approximated eighty-five hundred copies in this State alone.

### THE RELATIVE COMMERCIAL VALUES OF MERCHANTABLE FERTILIZERS.

The schedule of valuations prepared by Experiment Stations is intended to be used in explaining chemical analyses, and also to serve as a guide to farmers who estimate the commercial value of fertilizers from their guaranteed analyses. The methods followed in making up this schedule and in testing its accuracy have already been published in detail in former reports.

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS.

| | CENTS PER POUND. | | |
|---|---|---|---|
| | 1886. | 1887. | 1888. |
| Nitrogen in Ammonia Salts | 18½ | 17½ | 17½ |
| " " Nitrates | 18½ | 16 | 16 |
| " " Dried and Fine Ground Fish | 17 | 17½ | 16½ |
| Organic Nitrogen in Dried and Fine Ground Blood | 17 | 16 | 16½ |
| " " " Meat | 17 | 17½ | 16½ |
| " " " Cotton-Seed and Linseed Meal and in Castor Pom | 17 | 17½ | 16½ |
| " " " Fine Ground Bone | 17 | 16 | 16½ |
| " " " Fine Medium Bone | 15 | 14 | 13 |
| " " " Medium Bone | 13 | 12 | 10½ |
| " " " Coarse Medium Bone | 11 | 10 | 8½ |
| " " " Coarse Bone, Horn Shavings, Hair and Fish Scrap. | 9 | 8 | 8 |
| Phosphoric Acid, soluble in Water | 8 | 8 | 8 |
| " " " " Ammonium Citrate | 8 | 8 | 8 |
| " " insoluble in Dry, Fine Ground Fish and in Fine Bone. | 7 | 7 | 7 |
| " " " " Fine Medium Bone | 6 | 6 | 6 |
| " " " " Medium Bone | 5 | 5 | 5 |
| " " " " Coarse Medium Bone | 4 | 4 | 4 |
| " " " " Coarse Bone | 3 | 3 | 3 |
| " " " " Fine Ground Rock Phosphate | 2 | 2 | 2 |
| Potash as High-Grade Sulphate | 5½ | 5½ | 5½ |
| " " Kainit | 4¼ | 4¼ | 4¼ |
| " " Muriate | 4¼ | 4¼ | 4¼ |

Before this schedule was used by this Station its accuracy was subjected to the following severe test: Seventy-eight samples of crude

material, including all the best sources of plant-food, were collected, analyzed, and the retail cost of their nitrogen, phosphoric acid and potash accurately determined. The schedule secured in the above manner, of *manufacturers' average retail cash prices* for plant-food in fertilizer supplies, has already been considered in detail in this report. In comparison with the Station's schedule it appears as follows:

COMPARISON BETWEEN STATION'S SCHEDULE AND MANUFACTURERS' AVERAGE RETAIL PRICES OF PLANT-FOOD IN FERTILIZER SUPPLIES.

| | MANUFACTURERS' AVERAGE RETAIL PRICES FOR | | STATION'S SCHEDULE OF PRICES FOR |
|---|---|---|---|
| | 1887. | 1888. | 1888. |
| | cts. | cts. | cts. |
| Cost per pound of Nitrogen from Nitrate of Soda | 16 | 16¼ | 16 |
| " " " " " " Sulphate of Ammonia | 16.5 | 17 | 17½ |
| " " " " " " Dried Blood | 16.4 | 14.4 | 16½ |
| " " " " " " Dried Fish | 15.2 | 15.3 | 16½ |
| " " " " " " Ammonite and Castor Pom | 15.2 | 14.6 | 16½ |
| " " " " Soluble Phosphoric Acid from Bone Black | 8.2 | 7.5 | 8 |
| " " " " " " " " S. C. Rock | 7.5 | 6.2 | 8 |
| " " " " Reverted " " " Bone Black | 8.2 | 7.5 | 8 |
| " " " " " " " " S. C. Rock | 7.5 | 6.2 | 8 |
| " " " " Insoluble " " " Bone Black | 2.0 | 1.9 | 2 |
| " " " " " " " " S. C Rock | 1.9 | 1.5 | 2 |
| " " " " Potash from High-Grade Sulphate | 5.7 | 4.7 | 5½ |
| " " " " " " Double Sulph's of Pot. and Mag. | 6.7 | 6.1 | 5½ |
| " " " " " " Kainit | 4.0 | 5.1 | 4¼ |
| " " " " " " Muriate | 4.1 | 4.0 | 4¼ |

In seven cases there is a very close agreement between the valuations assumed by the Station and the prices charged by the manufacturers, while the Station's figures are too high by an average of 11.5 per cent. for all forms of organic nitrogen, by an average of 18.6 per cent. for phosphoric acid from bone black and South Carolina rock, and by an average of 14.5 per cent. for potash from high-grade sulphate. In the case of sulphate of potash and magnesia and of kainit the Station's prices are too low by 12.7 per cent. and 6 per cent. respectively.

The estimated values published in the following tables have been

calculated from the chemical analyses of the samples with the aid of the above schedule. These values, consequently, represent the cost of the plant-food only, without allowance for the expenses involved in mixing materials to form the so-called complete manures.

From estimates received by the Station from the leading fertilizer manufacturers on their mixing and bagging expenses, it was ascertained that this work could be done at an average cost of *two dollars and eighty-five cents per ton.* This amount, therefore, should be added to the Station's estimated value per ton, in order to ascertain, approximately, what a manufacturer's price should be before freight and similar charges have been incurred. Efforts have been made to secure from manufacturers the retail prices of their brands at their works, but without marked success, not more than thirty per cent. of those who are interested having responded. It has, however, been thought best to publish these as far as they have been given, and, in cases where the manufacturers have declined to furnish the information desired, to publish the prices which the retail merchants have given to the Station's Inspectors; at the same time calling attention to the possibility that these latter prices may be, in many cases, much higher than the manufacturers would charge.

In addition to the samples, 78 in number, reported upon a preceding page, the analyses may be found in the following tables of—

170 samples of Complete Fertilizers
19 samples of Ground Bone.
3 samples of Dissolved Bone.
11 samples of Miscellaneous Products.

The following list may be used as an index to the tables of

## COMPLETE FERTILIZERS.

LIST OF MANUFACTURERS WHOSE BRANDS HAVE BEEN SAMPLED AND ANALYZED THIS YEAR.

J. J. Allen's Sons................124 South Delaware Avenue, Philadelphia, Pa.
American Fish Guano Co...............................Hoffman's Wharf, Va.
American Oil and Fertilizer Co ..................................Greenwich, N. J.
William P. Adams ..............................248 Front Street, New York City.
Allentown Manufacturing Co............................................Allentown, Pa.
William T. Allen........................................Lawrence Station, N. J.
Max Ams..................................................................Bayside, N. J.
H. J. Baker & Bro.................................215 Pearl Street, New York City.
Bowker Fertilizer Co................................27 Beaver Street, New York City.

| | |
|---|---|
| Baugh & Sons Co | Philadelphia, Pa. |
| Brands & Reed | Belvidere, N. J. |
| Clark's Cove Guano Co | New Bedford, Mass. |
| Crocker Fertilizer Co | 60 Pearl Street, Buffalo, N. Y. |
| E. Frank Coe | 16 Burling Slip, New York City. |
| Carey & Bro | Lumberville, Pa. |
| Dambmann Bros. & Co | 27 East German Street, Baltimore, Md. |
| Davidge Fertilizer Co | 121 Front Street, New York City. |
| Equitable Fertilizer Co | Baltimore, Md. |
| Geo. B. Forrester | 169 Front Street, New York City. |
| Fruit Growers' Union | Hammonton, N. J. |
| J. C. Fifield & Sons | Bakersville, N. J. |
| Farmers' Fertilizer Co | Syracuse, N. Y. |
| Theodore Glaser | Linden, N. J. |
| Great Eastern Fertilizer Co | Rutland, Vt. |
| Hassinger Fertilizer Co | Mullica Hill, N. J. |
| Lister's A. C. Works | Newark, N. J. |
| Lewis & Price | Smyrna, Del. |
| Lord & Polk Co | Odessa, Del. |
| Mapes F. & P. Guano Co | 158 Front Street, New York City. |
| C. Myer, Jr | Maspeth, L. I. |
| A. Mitchell | Tremley, N. J. |
| H. S. Miller & Co | Newark, N. J. |
| N. J. Chemical Co | 129 South Front Street, Philadelphia, Pa. |
| Frederick Ludlam | 182 Front Street, New York City. |
| National Fertilizer Co | Bridgeport, Conn. |
| Orient Guano Manufacturing Co | 16 and 18 Exch. Place, New York City. |
| James E. Otis | Tuckerton, N. J. |
| Preston Fertilizer Co | Greenpoint, L. I. |
| Frederick Phillips | 131½ South Third Street, Philadelphia, Pa. |
| Pacific Guano Co | Boston, Mass. |
| J. Richmond | 147 South Front Street, Philadelphia, Pa. |
| Read & Co | 88 Wall Street, New York City. |
| Sharpless & Carpenter | 114 South Delaware Avenue, Philadelphia, Pa. |
| Scott Fertilizer Co | Elkton, Md. |
| M. L. Shoemaker & Co | Venango St. and Delaware Ave., Philadelphia, Pa. |
| J. I. Smith | Trenton, N. J. |
| R. Savidge | Mount Rose, N. J. |
| Stearns' Fertilizer Co | 133 Water Street, New York City. |
| I. P. Thomas & Son | 2 Chestnut Street, Philadelphia, Pa. |
| The John Taylor Co | Trenton, N. J. |
| J. E. Tygert & Co | 42 South Delaware Avenue, Philadelphia, Pa. |
| Taylor Bros. | Camden, N. J. |
| Williams & Clark Fertilizer Co | Cotton Exch. B'ld'g, Hanover Sq., N. Y. City. |
| Wando Phosphate Co | 203 Walnut Place, Philadelphia, Pa. |
| J. Wenderoth & Sons | 1046 Cooper Street, Camden, N. J. |
| Wilkinson & Co | 239 Centre Street, New York City. |
| Jeptha A. Wagener | Holtsville, N. Y. |

## Complete Fertilizers

### Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | BRAND. | MANUFACTURER. | SAMPLED BY. | Station Number. |
|---|---|---|---|---|
| 2594 | Lion Brand Fish and Potash | Wm. P. Adams, 248 Front St., N. Y. | D. R Warbasse, Hunt's Mills. | 2594 |
| 2600 | High-Grade Ammoniated Bone | " " " " " | J. B. Eckerson, River Vale. | 2600 |
| 2161 | Popular Phosphate | J. J. Allen's Sons, 121 S. Delaware Ave, Phila. | J. M. White, New Brunswick. | 2161 |
| 2164 | Potato Manure | " " " " " " " | " " " " | 2164 |
| 2329 | Marine Guano | " " " " " " " | Jas. C. Griscom, Woodbury. | 2329 |
| 2316 | Nitro Phosphate | " " " " " " " | Woodnutt Pettit, Salem. | 2316 |
| 2436 | Potato and Truck Manure | Wm. T. Allen, Lawrence Station, N. J. | Franklin Dye, Trenton. | 2436 |
| 2438 | Ammoniated Dissolved Bone, with Potash | " " " " " | " " " | 2438 |
| 2437 | Complete Phosphate | " " " " " | " " " | 2437 |
| 2591 | " Bone Manure | Allentown Manufacturing Co., Allentown, Pa. | D. R. Warbasse, Hunt's Mills. | 2591 |
| 2285 | " Bone Phosphate | " " " " " | J. M. White, New Brunswick. | 2285 |
| 2336 | Virginius Guano | American Fish Guano Co., Hoffman's Wharf, Va. | Jas. C. Griscom, Woodbury. | 2336 |
| 2326 | Bayside Fertilizer | " Oil and Fertilizer Co., Greenwich, N. J. | " " " | 2326 |
| 2135 | Superphosphate | Max Ams, Bayside, Cumberland County, N. J. | Theo. F. Baker, Bridgeton. | 2135 |
| 2487 | Pelican Bone | H. J. Baker & Bro., 215 Pearl Street, N. Y. | D. R. Warbasse, Hunt's Mills. | 2487 |
| 2500 | AA Ammoniated Superphosphate | " " " " " " " | John Grundy, Paterson. | 2500 |

## Complete Fertilizers

### Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | | Nitrogen. From Nitrates. | Nitrogen. From Ammonia Salts. | Nitrogen. From Organic Matter. | Nitrogen. Total Found. | Nitrogen. Total Guaranteed. | Phosphoric Acid. Soluble in Water. | Phosphoric Acid. Soluble in Ammonium Citrate. | Phosphoric Acid. Insoluble. | Phosphoric Acid. Total Found. | Phosphoric Acid. Total Guaranteed. | Phosphoric Acid. Available. Found. | Phosphoric Acid. Available. Guaranteed. | Potash. Found. | Potash. Guaranteed. | Chlorine. | Value of 2,000 lbs. at Station's Prices. | Selling Price of 2,000 lbs. at Factory. | Selling Price of 2,000 lbs. at Consumers' Depot. | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2594 | Adams' Lion Brand Fish and Potash..... | ..... | 0.33 | 2.38 | 2.71 | 2.46 | 3.61 | 3.99 | 1.80 | 9.40 | 6.00 | 7.60 | 3.00 | 4.76 | 4.32 | 1.75 | 27.39 | .......... | 32.00 | 2594 |
| 2600 | " High-Grade Ammoniated Bone.. | ...... | 0.91 | 1.45 | 2.36 | 2.46 | 4.70 | 3.14 | 1.85 | 9.69 | 10.00 | 7.84 | ........... | 5.29 | 3.78 | 0.44 | 27.30 | .......... | 38.00 | 2600 |
| 2161 | J. J. Allen's Popular Phosphate.............. | ...... | 0.30 | 0.82 | 1.12 | 0.82 | 1.23 | 5.26 | 4.28 | 10.77 | 8.00 | 6.49 | 6.00 | 2.24 | 2.50 | 5.10 | 18.78 | ........... | ........... | 2161 |
| 2164 | " " Potato Manure..................... | 1.59 | 0.98 | 0.81 | 3.38 | 2.87 | 5.47 | 1.96 | 2.47 | 9.90 | 9.00 | 7.43 | 6.50 | 8.12 | 7.50 | 7.76 | 31.55 | ........... | 42.00 | 2164 |
| 2329 | " " Marine Guano..................... | 0.87 | 1.31 | 1.73 | 3.94 | 3.69 | 5.13 | 1.60 | 2.81 | 9.54 | ........... | 6.73 | 7.00 | 5.00 | 5.00 | 4.77 | 30.24 | ........... | 43.00 | 2329 |
| 2316 | " " Nitro Phosphate.................. | 0.16 | 0.98 | 1.13 | 2.27 | 1.23 | 5.53 | 2.00 | 3.61 | 11.14 | .......... | 7.53 | 9.00 | 1.95 | 2.50 | 4.17 | 23.55 | ........... | 38.00 | 2316 |
| 2436 | Wm. T. Allen's Potato and Truck. ......... | 0.97 | 0.13 | 2.83 | 3.93 | 2.50 | 6.65 | 0.35 | 2.34 | 9.34 | 10.00 | 7.00 | 7.00 | 7.49 | 7.00 | 7.07 | 32.44 | ........... | 38.00 | 2436 |
| 2438 | Ammoniated Dis. Bone, with Potash...... | ...... | 0.12 | 2.24 | 2.36 | 1.64 | 8.64 | 1.14 | 3.04 | 12.82 | ........... | 9.78 | 7.00 | 2.01 | 2.00 | 2.16 | 27.43 | 25.00 | ........... | 2438 |
| 2437 | Wm. T. Allen's Complete Phosphate ..... | ...... | 0.64 | 2.47 | 3.11 | 2.46 | 9.91 | 0.94 | 2.28 | 13.13 | 12.00 | 10.85 | 10.00 | 3.05 | 2.00 | 2.77 | 31.71 | 30.00 | ........... | 2437 |
| 2591 | Complete Bone Manure......................... | ...... | 0.11 | 1.54 | 1.65 | 1.64 | 2.92 | 4.06 | 6.22 | 13.20 | 11.00 | 6.98 | 4.00 | 3.98 | 2.00 | 9.76 | 24.05 | 31.00 | .... ...... | 2591 |
| 2285 | " " Phosphate...................... | ...... | ...... | 1.76 | 1.76 | 1.64 | 6.60 | 1.88 | 2.50 | 10.98 | 11.00 | 8.48 | 10.00 | 2.26 | 2.00 | 5.40 | 22.80 | 34.00 | ........... | 2285 |
| 2336 | Virginius Guano............................................. | ...... | 2.05 | 1.78 | 3.83 | 3.28 | 0.19 | 5.45 | 7.30 | 12.94 | 10.00 | 5.64 | 7.00 | 1.81 | 1.00 | 1.76 | 27.99 | ........... | 38.00 | 2336 |
| 2326 | Bayside Fertilizer.......................................... | ...... | 0.13 | 1.78 | 1.91 | 1.64 | 3.09 | 3.29 | 2.43 | 8.81 | 9.00 | 6.38 | 6.00 | 2.20 | 1.00 | 4.83 | 19.86 | ........... | 27.00 | 2326 |
| 2135 | Max Ams' Superphosphate ..................... | ...... | 0.27 | 1.43 | 1.70 | 1.64 | 3.30 | 3.47 | 2.38 | 9.15 | ........... | 6.77 | 5.00 | 2.14 | 1.50 | 4.78 | 19.75 | ........... | 25.00 | 2135 |
| 2487 | Baker's Pelican Bone............................. | ...... | 1.47 | 1.33 | 2.80 | 1.85 | 9.60 | 0.75 | 0.39 | 10.74 | ........... | 10.35 | 8.00 | 2.61 | 2.25 | 3.44 | 28.55 | 32.50 | ........... | 2487 |
| 2500 | " AA Ammon'd Superphosphate... | ...... | 2.39 | 1.03 | 3.42 | 2.46 | 11.88 | 0.16 | 0.18 | 12.22 | .... ...... | 12.04 | 10.00 | 3.11 | 2.00 | 2.77 | 33.82 | 37.50 | ........... | 2500 |

# Complete Fertilizers

## Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | BRAND. | MANUFACTURER. | SAMPLED BY. | Station Number. |
|---|---|---|---|---|
| 2343 | Onion Manure | H. J. Baker & Bro., 215 Pearl Street, N. Y. | J. H. Denise, Freehold. | 2343 |
| 2543 | Special Corn Manure | " " " " " " " | A. J. Thompson, Readington. | 2543 |
| 2615 | Potato Manure | " " " " " " " | J. B. Eckerson, River Vale. | 2615 |
| 2350 | Hill and Drill | Bowker Fertilizer Co., 27 Beaver Street, N. Y. City. | Dennis C. Crane, Roselle. | 2350 |
| 2377 | Union Fish and Potash* | " " " " " | I. W. Nicholson, Camden. | 2377 |
| 2378 | " High-Grade Complete Manure, No. I.* | " " " " " | " " " | 2378 |
| 2545 | Ammoniated Bone Phosphate | " " " " " | Aaron J. Thompson, Readington. | 2545 |
| 2385 | Stockbridge Potato Manure | " " " " " | I. W. Nicholson, Camden. | 2385 |
| 2603 | Economical | Baugh & Sons Co., Philadelphia, Pa. | J. B. Eckerson, River Vale. | 2603 |
| 2155 | Peach Tree Special | Brands & Reed, Belvidere, N. J. | J. H. Denise, Freehold. | 2155 |
| 2595 | Soluble Bone and Potash | " " " " | D. R. Warbasse, Hunt's Mills. | 2595 |
| 2554 | Standard Phosphate | " " " " | Samuel J. Hixson, Bridgeville. | 2554 |
| 2275 | Defiance Complete Fertilizer | Clark's Cove Guano Co., New Bedford, Mass. | J. M. White, New Brunswick. | 2275 |
| 2669 | Peach and Fruit Tree | " " " " " " " | J. H. Denise, Freehold. | 2669 |
| 2276 | Great Planet "A" | " " " " " " " | J. M. White, New Brunswick. | 2276 |
| 2445 | King Philip Alkaline Guano | " " " " " " " | J. H. Denise, Freehold. | 2445 |

* Manufactured for the Fruit Growers' Union, Hammonton, N. J.

# Complete Fertilizers

## Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | | Nitrogen. | | | | | Phosphoric Acid. | | | | | | | Potash. | | Chlorine. | Value of 2,000 lbs. at Station's Prices. | Selling Price of 2,000 lbs. at Factory. | Selling Price of 2,000 lbs. at Consumers' Depot. | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Available. | | | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Soluble in Water. | Soluble in Ammonium Citrate. | Insoluble. | Total Found. | Total Guaranteed. | Found. | Guaranteed. | Found. | Guaranteed. | | | | | |
| 2343 | Baker's Onion Manure | ...... | 3.55 | 0.53 | 4.08 | 4.92 | 6.38 | 0.08 | ...... | 6.46 | .......... | 6.46 | 4.50 | 9.73 | 9.00 | 6.08 | 33.33 | .......... | 42.50 | 2343 |
| 2543 | " Special Corn Manure | ...... | 3.43 | 1.04 | 4.47 | 4.10 | 6.89 | 0.48 | 0.16 | 7.53 | .......... | 7.37 | 6.25 | 7.79 | 7.00 | 4.51 | 34.62 | 42.50 | .......... | 2543 |
| 2615 | " Potato Manure | ...... | 2.94 | 1.05 | 3.99 | 3.28 | 6.26 | 0.40 | 0.03 | 6.69 | .......... | 6.66 | 5.75 | 9.64 | 10.00 | 3.64 | 34.05 | 42.50 | .......... | 2615 |
| 2350 | Bowker's Hill and Drill | ...... | 0.61 | 2.37 | 2.98 | 2.50 | 10.08 | 0.90 | 2.43 | 13.41 | 12.00 | 10.98 | 10.00 | 1.35 | 1.08 | 1.48 | 30.14 | .......... | 38.00 | 2350 |
| 2377 | Union Fish and Potash | ...... | ...... | 2.86 | 2.86 | 2.25 | 4.23 | 2.17 | 6.80 | 13.20 | 8.00 | 6.40 | .......... | 3.10 | 2.16 | 3.26 | 26.40 | 28.50 | .......... | 2377 |
| 2378 | " High-Grade Complete, No. I. | 0.46 | 0.14 | 2.79 | 3.39 | 3.25 | 8.18 | 0.31 | 2.77 | 11.26 | 9.00 | 8.49 | 8.00 | 5.46 | 3.78 | 5.29 | 31.06 | 36.00 | .......... | 2378 |
| 2545 | Bowker's Ammoniated Bone Phos. | ...... | 0.10 | 2.33 | 2.43 | 2.00 | 8.31 | 1.39 | 3.93 | 13.63 | 11.00 | 9.70 | 10.00 | 1.54 | 1.08 | 2.07 | 27.23 | .......... | 32.00 | 2545 |
| 2385 | Stockbridge Potato Manure | 0.60 | 1.27 | 2.31 | 4.18 | 3.25 | 7.08 | 2.09 | 3.55 | 12.72 | 8.00 | 9.17 | 7.00 | 4.98 | 2.70 | 4.90 | 35.49 | .......... | 43.00 | 2385 |
| 2603 | Baugh's Economical. | ...... | 0.19 | 1.68 | 1.87 | 1.64 | 4.09 | 2.89 | 3.98 | 10.96 | .......... | 6.98 | 5.00 | 2.28 | 2.16 | 4.33 | 21.70 | 28.00 | .......... | 2603 |
| 2155 | Brands & Reed's Peach Tree | ...... | ...... | 2.75 | 2.75 | 0.82 | 0.28 | 4.61 | 8.36 | 13.25 | 12.00 | 4.89 | .......... | 4.07 | 4.32 | 9.12 | 25.94 | .......... | 32.00 | 2155 |
| 2595 | " " Sol. Bone and Potash. | ...... | 0.15 | 0.71 | 0.86 | ........ | 1.44 | 2.20 | 2.27 | 5.91 | 9.00 | 3.64 | .......... | 2.70 | 1.35 | 5.31 | 12.50 | .......... | 30.00 | 2595 |
| 2554 | " " Standard Phosphate. | ...... | ...... | 0.60 | 0.60 | 0.82 | 4.42 | 2.34 | 5.08 | 11.84 | 9.00 | 6.76 | .......... | 1.81 | 1.62 | 4.16 | 17.41 | .......... | 30.00 | 2554 |
| 2275 | Clark's Cove Defiance Complete | ..... | 0.35 | 0.94 | 1.29 | 0.83 | 0.73 | 3.82 | 4.85 | 9.40 | 8.00 | 4.55 | 6.00 | 2.45 | 2.00 | 2.38 | 16.79 | .......... | .......... | 2275 |
| 2669 | " " Peach and Fruit Tree | 0.27 | 0.10 | 0.72 | 1.09 | 0.62 | 3.00 | 3.34 | 1.47 | 7.81 | 5.50 | 6.34 | .......... | 6.09 | 6.00 | 8.54 | 19.93 | .......... | 26.00 | 2669 |
| 2276 | " " Great Planet "A" | 0.91 | 1.23 | 1.80 | 3.94 | 3.28 | 6.85 | 0.75 | 1.33 | 8.93 | .......... | 7.60 | 7.00 | 8.72 | 9.50 | 6.74 | 33.53 | .......... | 44.00 | 2276 |
| 2445 | " " King Philip | 0.18 | 0.31 | 1.35 | 1.84 | 1.23 | 3.38 | 3.18 | 4.19 | 10.75 | .......... | 6.56 | 6.50 | 3.14 | 3.00 | 1.90 | 21.96 | .......... | 32.00 | 2445 |

## Complete Fertilizers

### Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | BRAND. | MANUFACTURER. | SAMPLED BY. | Station Number. |
|---|---|---|---|---|
| 2134 | Excelsior, No. 1 | Carey & Bro., Lumberville, Pa. | Theo. F. Baker, Bridgeton. | 2134 |
| 2151 | High-Grade Ammoniated Bone | E. Frank Coe, 16 Burling Slip, N. Y. | J. H. Denise, Freehold. | 2151 |
| 2529 | Excelsior Guano | " " " " " | Wm. R. Ward, Newark. | 2529 |
| 2528 | " " Blue Brand | " " " " " | " " " | 2528 |
| 2341 | " " Red Brand | " " " " " | J. H. Denise, Freehold. | 2341 |
| 2368 | XXV. Ammoniated Bone Superphosphate | " " " " " | Franklin Dye, Trenton. | 2368 |
| 2460 | Ground Bone | " " " " " | J. B. Eckerson, River Vale. | 2460 |
| 2454 | Alkaline Bone | " " " " " | Geo. A. MacBean, Lakewood. | 2454 |
| 2556 | Potato Fertilizer | " " " " " | Samuel J. Hixson, Bridgeville. | 2556 |
| 2597 | Peach Tree | " " " " " | D. R. Warbasse, Hunt's Mills. | 2597 |
| 2568 | Vegetable Bone Superphosphate | Crocker Fertilizer and Chemical Co., Buffalo, N. Y. | J. J. Mitchell, Whippany. | 2568 |
| 2277 | Wheat and Corn Phosphate | " " " " " " " | J. M. White, New Brunswick. | 2277 |
| 2492 | Queen City Phosphate | " " " " " " " | D. R. Warbasse, Hunt's Mills. | 2492 |
| 2308 | Potato, Hop and Tobacco Phosphate | " " " " " " " | Woodnutt Pettit, Salem. | 2308 |
| 2493 | Ammoniated Bone Superphosphate | " " " " " " " | D. R. Warbasse, Hunt's Mills. | 2493 |

## Complete Fertilizers

**Furnishing Nitrogen, Phosphoric Acid and Potash.**

| Station Number. | | Nitrogen. | | | | | Phosphoric Acid. | | | | | | | Potash. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Available. | | | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Soluble in Water. | Soluble in Ammonium Citrate. | Insoluble. | Total Found. | Total Guaranteed. | Found. | Guaranteed. | Found. | Guaranteed. | Chlorine. | Value of 2,000 lbs. at Station's Prices. | Selling Price of 2,000 lbs. at Factory. | Selling Price of 2,000 lbs. at Consumers' Depot. | Station Number. |
| 2134 | Carey's Excelsior, No. 1 | ...... | ...... | 0.29 | 0.29 | ........ | ...... | ...... | ........ | 0.20 | ..... ...... | .......... | ............ | 0.51 | ........ | 9.47 | 1.51 | ........ | 45.00 | 2134 |
| 2151 | Coe's H. G. Ammoniated Bone | ...... | 0.88 | 1.55 | 2.43 | 2.05 | 8.53 | 0.94 | 2.45 | 11.92 | 10.00 | 9.47 | 9.00 | 3.36 | 1.62 | 0.42 | 28.68 | ........ | 35.00 | 2151 |
| 2529 | " Excelsior | ...... | 0.89 | 2.51 | 3.40 | 3.28 | 8 08 | 1 39 | 1.28 | 10.75 | 10.00 | 9.47 | ............ | 3.93 | 3.24 | 0.46 | 31.99 | ........ | 43.00 | 2529 |
| 2528 | " " Blue Brand | ..... | 1.46 | 2.70 | 4.16 | 6.56 | 7.03 | 1.67 | 1.95 | 10.65 | 6.00 | 8.70 | ............ | 2.74 | 2.16 | 0.81 | 32.40 | ........ | 48.00 | 2528 |
| 2341 | " " Red Brand | ...... | 0.69 | 2.26 | 2.95 | 3.28 | 7.55 | 0.89 | 1.15 | 9.59 | 10.00 | 8.44 | ............ | 5.64 | 5.94 | 0.50 | 30.56 | ........ | 43.50 | 2341 |
| 2368 | " XXV. Ammon. Bone Super | ...... | 0.13 | 1 37 | 1.50 | 0.82 | 8.24 | 1.49 | 3.00 | 12.73 | 8.50 | 9.73 | 7.00 | 0.96 | 0.81 | 0 28 | 23.59 | ........ | 25.00 | 2368 |
| 2460 | " Ground Bone | ...... | 0.52 | 1.78 | 2.30 | 2.46 | 0.54 | 2.24 | 10.15 | 12.93 | 11.00 | 2.78 | ............ | 3.13 | 1.08 | 6.71 | 21.24 | ........ | 40.00 | 2460 |
| 2454 | " Alkaline Bone | ...... | 0 11 | 2.59 | 2.70 | 0.82 | 2.78 | 4.14 | 4.99 | 11.91 | 10.00 | 6.92 | 9.00 | 2.73 | 1.62 | 5.65 | 25.32 | ........ | 32.00 | 2454 |
| 2556 | " Potato Fertilizer | ...... | 0.19 | 2 34 | 2.53 | 2.05 | 7.30 | 1.07 | 1.92 | 10.29 | 10.00 | 8.37 | 8.00 | 5.27 | 4.86 | 2.35 | 27.96 | ........ | 42.00 | 2556 |
| 2597 | " Peach Tree | ...... | 0.11 | 1.19 | 1.30 | 1.23 | 7.74 | 1.22 | 2.79 | 11.75 | 10.00 | 8.96 | 8.00 | 4.59 | 4.86 | 0.60 | 25.17 | ........ | 34.00 | 2597 |
| 2568 | Crocker's Vegetable Bone Superphos. | ...... | 0.24 | 4.66 | 4.90 | 5.00 | 4 36 | 1.34 | 2.29 | 7.99 | ............ | 5.70 | 6.00 | 7.16 | 6.00 | 7.17 | 33.73 | ........ | 42.00 | 2568 |
| 2277 | " Wheat and Corn Phosphate. | ..... | 0.10 | 2.61 | 2.71 | 2.05 | 8 64 | 0.80 | 2.27 | 11.71 | 11.00 | 9.44 | 10.00 | 2.51 | 1.62 | 2.52 | 28.08 | ........ | ............ | 2277 |
| 2492 | " Queen City Phosphate | ..... | 0.12 | 2.79 | 2.91 | 1.64 | 8 45 | 0.93 | 1.41 | 10.79 | 9.00 | 9.38 | 8.00 | 1.66 | 1.08 | 1.64 | 27.46 | ........ | ............ | 2492 |
| 2308 | " Potato, Hop and Tobacco Phos. | ...... | 0.10 | 2.56 | 2.66 | 2.05 | 8.01 | 1.15 | 1.63 | 10.79 | 9.00 | 9.16 | 8.00 | 4.13 | 3.24 | 4.15 | 27.95 | ........ | 40.00 | 2308 |
| 2493 | " Ammoniated Bone Superphos | ...... | 0.14 | 3.26 | 3.40 | 2.87 | 8 85 | 0.59 | 1.44 | 10.88 | 9.00 | 9.44 | 8.00 | 1.66 | 1.00 | 1.65 | 28.79 | ........ | 36.00 | 2493 |

## Complete Fertilizers

### Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | BRAND. | MANUFACTURER. | SAMPLED BY. | Station Number. |
|---|---|---|---|---|
| 2171 | Potato Fertilizer | Dambmann Bros. & Co., Baltimore, Md. | J. M. White, New Brunswick. | 2171 |
| 2614 | Wheat, Corn and Oats | " " " " " | J. B. Eckerson, River Vale. | 2614 |
| 2561 | Arlington, for Truck | " " " " " | Woodnutt Pettit, Salem. | 2561 |
| 2608 | Arlington B, for All Crops | " " " " " | J. B. Eckerson, River Vale. | 2608 |
| 2636 | Potato Manure | Davidge Fertilizer Co., 121 Front St., N. Y. | Dennis C. Crane, Roselle. | 2636 |
| 2637 | Vegetator, Fish and Potash | " " " " " " | " " " | 2637 |
| 2282 | Special Favorite for Cereals | " " " " " " | J. M. White, New Brunswick. | 2282 |
| 2484 | Esmeralda Potato Compound | Equitable Fertilizer Co., Baltimore, Md. | Jas. C. Griscom, Woodbury. | 2484 |
| 2485 | " Tomato Compound | " " " " " | " " " | 2485 |
| 2671 | Selected Esmeralda Guano | " " " " " | J. H. Denise, Freehold. | 2671 |
| 2670 | Rose Bone Phosphate | " " " " " | " " " | 2670 |
| 2510 | Potato Manure | J. C. Fifield & Sons, Bakersville, N. J. | Chas. Kraus, Egg Harbor City. | 2510 |
| 2511 | Astral Bone | " " " " " | " " " " " | 2511 |
| 2512 | Truckers' Delight | " " " " " | " " " " " | 2512 |
| 2429 | Fish and Potash | " " " " " | J. H. Richardson, Rio Grande. | 2429 |
| 2623 | Reaper Potato Manure | Farmers' Fertilizer Co., Syracuse, N. Y. | J. B. Eckerson, River Vale. | 2623 |
| 2624 | Standard Bone Phosphate | " " " " " | " " " " | 2624 |

## Complete Fertilizers

### Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | | Nitrogen. | | | | | Phosphoric Acid. | | | | | | | Potash. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Available. | | | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Soluble in Water. | Soluble in Ammonium Citrate. | Insoluble. | Total Found. | Total Guaranteed. | Found. | Guaranteed. | Found. | Guaranteed. | Chlorine. | Value of 2,000 lbs. at Station's Prices. | Selling Price of 2,000 lbs. at Factory. | Selling Price of 2,000 lbs. at Consumers' Depot. | Station Number. |
| 2171 | Dambmann's Potato Fertilizer | 0.44 | 0.11 | 2.25 | 2.80 | 2.46 | 7.20 | 0.84 | 1.20 | 9.24 | 9.00 | 8.04 | 6.00 | 8.74 | 9.00 | 8.44 | 30.24 | 37.00 | .......... | 2171 |
| 2614 | " Wheat, Corn and Oats | ...... | ...... | 2.12 | 2.12 | 1.64 | 7.87 | 1.68 | 2.25 | 11.80 | .......... | 9.55 | 9.00 | 2.29 | 2.00 | 3.06 | 25.58 | 27.00 | .......... | 2614 |
| 2561 | " Arlington, for Truck | 0.71 | 0.62 | 2.11 | 3.44 | 3.28 | 9.18 | 0.81 | 1.25 | 11.24 | 10.00 | 9.99 | 9.50 | 2.74 | 2.50 | 2.87 | 30.90 | 34.00 | .......... | 2561 |
| 2608 | " Arlington B, for All Crops | 0.81 | ...... | 1.49 | 2.30 | 1.84 | 7.95 | 1.36 | 1.62 | 10.93 | .......... | 9.31 | 9.00 | 2.42 | 2.25 | 3.22 | 25.74 | 30.00 | .......... | 2608 |
| 2636 | Davidge's Potato Manure | ...... | 0.26 | 2.52 | 2.78 | 2.87 | 7.97 | 0.50 | 0.40 | 8.87 | 10.00 | 8.47 | 9.00 | 4.23 | 4.00 | 3.04 | 27.17 | 35.00 | .......... | 2636 |
| 2637 | Vegetator, Fish and Potash | ...... | 0.40 | 3.15 | 3.55 | 3.28 | 5.22 | 0.73 | 0.41 | 6.36 | .......... | 5.95 | 5.00 | 4.27 | 4.00 | 3.97 | 25.83 | 32.75 | .......... | 2637 |
| 2282 | Davidge's Special Favorite | ...... | 0.12 | 1.46 | 1.58 | 1.23 | 9.21 | 0.73 | 1.22 | 11.16 | 12.00 | 9.94 | 10.00 | 1.72 | 1.50 | 1.65 | 23.34 | 30.75 | .......... | 2282 |
| 2484 | Esmeralda Potato Compound | ...... | 0.98 | 1.79 | 2.77 | 2.05 | 2.78 | 4.08 | 3.76 | 10.62 | 8.00 | 6.86 | 6.00 | 7.45 | 7.00 | 7.92 | 28.91 | .......... | 38.00 | 2484 |
| 2485 | " Tomato | ...... | 0.84 | 1.74 | 2.58 | 2.66 | 2.11 | 4.06 | 4.48 | 10.65 | 10.00 | 6.17 | 8.00 | 7.35 | 7.00 | 7.70 | 27.84 | .......... | 38.00 | 2485 |
| 2671 | Selected Esmeralda | ...... | 2.15 | 0.72 | 2.87 | 3.28 | 3.96 | 3.15 | 5.86 | 12.97 | 14.00 | 7.11 | 6.00 | 1.41 | 2.00 | 1.74 | 26.15 | .......... | 45.00 | 2671 |
| 2670 | Rose Bone Phosphate | ...... | ...... | 0.26 | 0.26 | 0.31 | 6.47 | 3.77 | 5.18 | 15.42 | 11.50 | 10.24 | 9.50 | 2.67 | 2.00 | 3.09 | 22.67 | .......... | 27.50 | 2670 |
| 2510 | Fifield's Potato Manure | ...... | 0.11 | 1.79 | 1.90 | 1.64 | 4.67 | 1.51 | 2.52 | 8.70 | .......... | 6.18 | 7.00 | 9.95 | 7.00 | 9.08 | 26.52 | .......... | 35.00 | 2510 |
| 2511 | " Astral Bone | ...... | 0.17 | 2.96 | 3.13 | 2.46 | 5.89 | 1.48 | 3.84 | 11.21 | .......... | 7.37 | 8.00 | 2.90 | 2.00 | 2.75 | 27.52 | .......... | 34.00 | 2511 |
| 2512 | " Trucker's Delight | ...... | ...... | 1.23 | 1.23 | 0.82 | 5.66 | 1.27 | 2.49 | 9.42 | .......... | 6.93 | 7.00 | 1.88 | 1.00 | 4.10 | 18.49 | .......... | 26.00 | 2512 |
| 2429 | " Fish and Potash | ...... | 0.40 | 2.42 | 2.82 | 2.46 | 2.28 | 1.19 | 0.63 | 4.10 | .......... | 3.47 | 2.00 | 3.61 | 2.00 | 7.24 | 18.39 | .......... | 30.00 | 2429 |
| 2623 | Reaper Potato Manure | 0.80 | ...... | 1.96 | 2.76 | 1.64 | 5.03 | 1.56 | 1.42 | 8.01 | .......... | 6.59 | 5.50 | 3.70 | 4.00 | 2.83 | 23.97 | 24.00 | .......... | 2623 |
| 2624 | Standard Bone Phosphate | ...... | ...... | 0.62 | 0.62 | 0.82 | 8.33 | 0.96 | 1.69 | 10.98 | 11.00 | 9.29 | 9.00 | 1.28 | 3.00 | 1.29 | 19.14 | 24.00 | .......... | 2624 |

## Complete Fertilizers

### Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | BRAND. | MANUFACTURER. | SAMPLED BY. | Station Number. |
|---|---|---|---|---|
| 2625 | Farmers' Fair and Square | Farmers' Fertilizer Co., Syracuse, N. Y. | J. B. Eckerson, River Vale. | 2625 |
| 2638 | Potato Manure | Geo. B. Forrester, 169 Front St., New York. | Dennis C. Crane, Roselle. | 2638 |
| 2354 | Union Co. Fertilizer | Theodore Glaser, Linden, N. J. | " " " | 2354 |
| 2339 | Vegetable and Vine | Great Eastern Fertilizer Co., Rutland, Vermont. | J. H. Denise, Freehold. | 2339 |
| 2342 | Peach Tree Fertilizer | " " " " " " | " " " | 2342 |
| 2332 | Complete Manure | Hassinger Fertilizer Co., Mullica Hill, N. J. | Jas. C. Griscom, Woodbury. | 2332 |
| 2601 | American Chemical Guano | Improved Phosphatic Fertilizer Co., Little Ferry, N. J. | J. B. Eckerson, River Vale. | 2601 |
| 2303 | Harvest Queen Phosphate | Lister's Agricultural Chemical Works, Newark, N. J. | J. M. White, New Brunswick. | 2303 |
| 2572 | Raw Bone Phosphate | " " " " " " | J. J. Mitchell, Whippany. | 2572 |
| 2573 | Ammoniated Dissolved Bone | " " " " " " | " " " | 2573 |
| 2598 | Potato No. 2 | " " " " " " | D. R. Warbasse, Hunt's Mills. | 2598 |
| 2618 | Corn Manure | " " " " " " | J. B. Eckerson, River Vale. | 2618 |
| 2656 | U. S. Superphosphate | " " " " " " | J. S. Ten Eyck, North Branch. | 2656 |
| 2532 | Success | " " " " " " | Wm. R. Ward, Newark. | 2532 |
| 2575 | Standard Superphosphate of Lime | " " " " " " | J. J. Mitchell, Whippany. | 2575 |
| 2585 | Potato Manure | " " " " " " | Franklin Dye, Trenton. | 2585 |

## Complete Fertilizers

**Furnishing Nitrogen, Phosphoric Acid and Potash.**

| Station Number. | | Nitrogen. | | | | | Phosphoric Acid. | | | | | | | Potash. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Available. | | | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Soluble in Water. | Soluble in Ammonium Citrate. | Insoluble. | Total Found. | Total Guaranteed. | Found. | Guaranteed. | Found. | Guaranteed. | Chlorine. | Value of 2,000 lbs. at Station's Prices. | Selling Price of 2,000 lbs. at Factory. | Selling Price of 2,000 lbs. at Consumers' Depot. | Station Number. |
| 2625 | Farmers' Fair and Square | 0,50 | ...... | 1.65 | 2.15 | 2.46 | 6.72 | 1.22 | 1.28 | 9.22 | ...... | 7.94 | 7.00 | 2.01 | 1.00 | 1.44 | 22.26 | 25.00 | ...... | 2625 |
| 2638 | Forrester's Potato Manure | 0.80 | 3.97 | 0 30 | 5.07 | 3.69 | 6 14 | 0.72 | 0.12 | 6.98 | ...... | 6.86 | 5.50 | 12.36 | 10.00 | 6 93 | 39.80 | 43.00 | ...... | 2638 |
| 2354 | Glaser's Union Co. Fertilizer. | ...... | 1.75 | 2.06 | 3.81 | 1.64 | 0.56 | 3 51 | 0.64 | 4.71 | 3.58 | 4.07 | ...... | 2.78 | 2.00 | 2.00 | 22.22 | ...... | 25.00 | 2354 |
| 2339 | Great Eastern Vegetable and Vine | ...... | 0.12 | 2 30 | 2.42 | 2.05 | 5.70 | 1.52 | 3.39 | 10.61 | ...... | 7.22 | 6.00 | 4.28 | 4.00 | 4.15 | 25.23 | 30.00 | ...... | 2339 |
| 2342 | " " Peach Tree | ...... | ...... | 1 15 | 1.15 | 0.82 | 3.90 | 1.90 | 2.11 | 7.91 | 6.00 | 5.80 | ...... | 4.16 | 4.86 | 6.61 | 18.12 | 28.00 | ...... | 2342 |
| 2332 | Hassinger's Complete Manure | ...... | ...... | 2.39 | 2.39 | 1.64 | 4.45 | 2.05 | 5.20 | 11.70 | 11.00 | 6.50 | ...... | 2.96 | 4.00 | 6.05 | 23.93 | ...... | 32.00 | 2332 |
| 2601 | American Chemical Guano | 0.13 | 0.13 | 0.66 | 0.92 | ...... | 4.32 | 1.31 | 3.77 | 9.40 | ...... | 5.63 | ...... | 0.76 | ...... | 5.84 | 15.11 | ...... | 45.00 | 2601 |
| 2303 | Lister's Harvest Queen Phosphate | ...... | 0.22 | 1.39 | 1.61 | 1.03 | 7.58 | 2 65 | 1.94 | 12.17 | ...... | 10.23 | 10.50 | 1.80 | 1.50 | 1.07 | 24.62 | ...... | 26.00 | 2303 |
| 2572 | " Raw Bone Phosphate | ...... | 0.42 | 2.97 | 3.39 | 2.66 | 0.59 | 9.14 | 5 18 | 14.82 | 11.50 | 9.64 | 4.50 | 0.33 | 1.08 | 0.22 | 30.70 | ...... | 27.00 | 2572 |
| 2573 | " Ammoniated Dis. Bone | ...... | 0.47 | 1.73 | 2.20 | 1.80 | 7 20 | 2.87 | 1.71 | 11.78 | 11.00 | 10.07 | 9.00 | 1.64 | 1.50 | 1.58 | 26.24 | ...... | 28.00 | 2573 |
| 2598 | " Potato No. 2 | ...... | 0.21 | 1.80 | 2.01 | 1.64 | 7.08 | 5.14 | 1.28 | 13.50 | ...... | 12.22 | 8.00 | 5.00 | 4.00 | 4.75 | 31.61 | ...... | 35.00 | 2698 |
| 2618 | " Corn Manure | 0.62 | 1.69 | 1.84 | 4.15 | 3.69 | 8 24 | 0.50 | 0.27 | 9.01 | ...... | 8.74 | 9.00 | 6.06 | 7.00 | 6 52 | 33.63 | ...... | 42.00 | 2618 |
| 2656 | " U. S. Superphosphate | ...... | 0.38 | 1.63 | 2.01 | 1.31 | 6 62 | 1.70 | 1.28 | 9.60 | 7.00 | 8.32 | 6.00 | 2.46 | 2.00 | 5.17 | 23.21 | ...... | 25.00 | 2656 |
| 2532 | " Success | ...... | 0.34 | 1.48 | 1.82 | 1.03 | 7.16 | 3.32 | 1.66 | 12.04 | ...... | 10.38 | 10.50 | 1.74 | 1.50 | 1.13 | 25.23 | ...... | 25.00 | 2532 |
| 2575 | " Standard Superphos. of Lime | ...... | 0.51 | 2 27 | 2.78 | 2.34 | 7.68 | 3.35 | 1.64 | 12.67 | 12.00 | 11.03 | 10.00 | 2.08 | 1.50 | 2 26 | 29.68 | ...... | 32.00 | 2575 |
| 2585 | " Potato Manure | ...... | 2.53 | 2.22 | 4.75 | 3.69 | 8.31 | 1.55 | 0.41 | 10.27 | ...... | 9.86 | 8.50 | 6.68 | 7.00 | 5.96 | 37.90 | ...... | 40.00 | 2585 |

## Complete Fertilizers

### Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | BRAND. | MANUFACTURER. | SAMPLED BY. | Station Number. |
|---|---|---|---|---|
| 2313 | Champion Fertilizer | Lord & Polk Chemical Co., Odessa, Delaware. | Woodnutt Pettit, Salem. | 2313 |
| 2380 | Union High-Grade Complete Manure, No. III.* | " " " " " " | I. W. Nicholson, Camden. | 2380 |
| 2381 | Truxillo Guano | " " " " " " | " " " | 2384 |
| 2562 | Farmers' Bone Phosphate | Lewis & Price, Smyrna, Delaware. | Woodnutt Pettit, Salem. | 2562 |
| 2348 | "A" Brand | Mapes' F. & P. Guano Co., 158 Front Street, N. Y. City. | Dennis C. Crane, Roselle. | 2348 |
| 2514 | Potato Manure | " " " " " " | Chas. Kraus, Egg Harbor City. | 2514 |
| 2675 | Peach Tree Manure | " " " " " " | Aaron J. Thompson, Readington. | 2675 |
| 2157 | Fruit and Vine Manure | " " " " " " | J. M. White, New Brunswick. | 2157 |
| 2469 | Corn Manure | " " " " " " | J. B. Eckerson, River Vale. | 2469 |
| 2504 | Cabbage and Cauliflower | " " " " " " | John Grundy, Paterson. | 2504 |
| 2536 | Complete for Light Soils | " " " " " " | Wm. R. Ward, Newark. | 2536 |
| 2298 | Grass and Grain Spring Top-dressing | " " " " " " | Geo. A. MacBean, Lakewood. | 2298 |
| 2304 | Ammoniated Dissolved Bone, with Potash | " " " " " " | J. M. White, New Brunswick. | 2304 |
| 2419 | Dried and Ground Fish | " " " " " " | I. W. Nicholson, Camden. | 2419 |
| 2535 | Peruvian Guano, Unmanipulated | " " " " " " | Wm. R. Ward, Newark. | 2535 |
| 2538 | Top-dressing, with Plaster | " " " " " " | " " " | 2538 |

*Manufactured for the Fruit Growers' Union, Hammonton, N. J.

# Complete Fertilizers

## Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | | Nitrogen. | | | | | Phosphoric Acid. | | | | | | | Potash. | | Chlorine. | Value of 2,000 lbs. at Station's Prices. | Selling Price of 2,000 lbs. at Factory. | Selling Price of 2,000 lbs. at Consumers' Depot. | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Soluble in Water. | Soluble in Ammonium Citrate. | Insoluble. | Total Found. | Total Guaranteed. | Available. Found. | Available. Guaranteed. | Found. | Guaranteed. | | | | | |
| 2313 | Lord & Polk's Champion | ...... | 0.14 | 1.49 | 1.63 | 1.23 | 4.59 | 3.06 | 3.71 | 11.36 | ........... | 7.65 | 7.00 | 3.06 | 2.00 | 3.81 | 22.77 | ........... | 26.00 | 2313 |
| 2380 | Union H. G. Complete Manure, No. III. | 1.56 | 0.16 | 2.59 | 4.31 | 3.69 | 6.47 | 0.92 | 1.51 | 8.90 | ........... | 7.39 | 7.00 | 5.91 | 7.00 | 8.30 | 31.85 | 33.00 | ........... | 2380 |
| 2381 | Truxillo Guano | 0.96 | 1.69 | 1.76 | 4.41 | 2.87 | 7.05 | 0.93 | 2.07 | 10.05 | ........... | 7.98 | 9.00 | 5.59 | 5.00 | 9.65 | 33.23 | 38.00 | ........... | 2384 |
| 2562 | Lewis & Price, Farmers' Bone Phos. | ...... | 0.13 | 1.30 | 1.43 | 1.64 | 5.52 | 2.04 | 2.62 | 10.18 | 10.00 | 7.56 | ........... | 3.03 | 3.00 | 6.80 | 20.99 | ........... | 30.00 | 2562 |
| 2348 | Mapes' "A" Brand | 0.61 | 0.91 | 1.65 | 3.23 | 2.46 | 4.05 | 5.23 | 4.58 | 13.86 | 12.00 | 9.28 | 10.00 | 3.56 | 2.50 | 5.14 | 31.42 | ........... | 38.00 | 2348 |
| 2514 | " Potato Manure | 0.83 | 1.54 | 1.89 | 4.26 | 3.69 | 3.95 | 5.82 | 3.35 | 13.12 | ........... | 9.77 | 8.00 | 7.19 | 6.00 | 0.71 | 39.96 | ........... | 46.00 | 2514 |
| 2675 | " Peach Tree Manure | 0.39 | 0.68 | 1.64 | 2.71 | 1.64 | 4.83 | 3.98 | 1.47 | 10.28 | ........... | 8.81 | 8.00 | 9.11 | 8.00 | 4.27 | 32.64 | ........... | 35.00 | 2675 |
| 2157 | " Fruit and Vine | 0.41 | 0.56 | 1.89 | 2.86 | 1.64 | 7.30 | 2.26 | 1.12 | 10.68 | 7.00 | 9.56 | ........... | 11.15 | 11.00 | 0.44 | 37.98 | ........... | 41.00 | 2157 |
| 2469 | " Corn Manure | 1.03 | 1.83 | 1.61 | 4.47 | 3.69 | 5.91 | 4.22 | 2.45 | 12.58 | 10.00 | 10.13 | 8.00 | 6.61 | 6.00 | 6.64 | 38.65 | ........... | 43.00 | 2469 |
| 2504 | " Cabbage and Cauliflower | 0.77 | 2.45 | 2.32 | 5.54 | 4.51 | 2.77 | 4.82 | 2.48 | 10.07 | 6.00 | 7.59 | ........... | 10.19 | 8.00 | 9.33 | 41.45 | ........... | 42.00 | 2504 |
| 2536 | " Complete for Light Soils | ...... | 2.53 | 2.40 | 4.93 | 4.92 | 2.19 | 4.62 | 4.44 | 11.25 | 8.00 | 6.81 | 6.00 | 7.19 | 6.00 | 6.78 | 37.22 | ........... | 44.00 | 2536 |
| 2298 | " G. and G. Spring Top-dressing | 0.80 | 1.73 | 2.16 | 4.69 | 4.10 | 4.24 | 4.60 | 3.41 | 12.25 | ........... | 8.84 | 7.00 | 5.71 | 5.00 | 5.08 | 37.22 | ........... | 46.00 | 2298 |
| 2304 | " Ammoniated Dissolved Bone | ...... | ...... | 1.90 | 1.90 | 1.23 | 4.42 | 6.30 | 2.84 | 13.56 | ........... | 10.72 | 10.00 | 2.10 | 1.50 | 4.69 | 27.28 | ........... | 30.00 | 2304 |
| 2419 | " Dried and Ground Fish | ...... | 0.18 | 4.26 | 4.44 | 4.10 | 0.29 | 4.21 | 5.15 | 9.65 | 6.00 | 4.50 | ........... | 3.52 | 3.00 | 5.93 | 28.82 | ........... | 36.00 | 2419 |
| 2535 | " Peruvian Guano, Unmanip. | 0.40 | 2.39 | 1.09 | 3.88 | ........ | 3.24 | 7.83 | 9.77 | 20.84 | ........... | 11.07 | ........... | 4.34 | ........... | 2.99 | 40.80 | ........... | ........... | 2535 |
| 2538 | " Top dressing with Plaster | 2.60 | 0.12 | 0.17 | 2.89 | 2.46 | 0.79 | 3.33 | 0.12 | 4.24 | 4.00 | 4.12 | ........... | 3.59 | 2.50 | 3.12 | 19.05 | ........... | 35.00 | 2538 |

## Complete Fertilizers

### Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | BRAND. | MANUFACTURER. | SAMPLED BY. | Station Number. |
|---|---|---|---|---|
| 2650 | Nitrogenized Superphosphate | Mapes' F. and P. Guano Co., 158 Front Street, N. Y. | J. S. Ten Eyck, North Branch. | 2650 |
| 2673 | Complete Manure for General Use | " " " " " " | J. H. Denise, Freehold. | 2673 |
| 2157 | Fruit and Vine Manure | " " " " " " | J. M. White, New Brunswick. | 2157 |
| 2620 | Potato Manure | H. S. Miller & Co., Newark, N. J. | J. B. Eckerson, River Vale. | 2620 |
| 2621 | Standard Superphosphate of Lime | " " " " | " " " " | 2621 |
| 2622 | Harvest Queen | " " " " | " " " " | 2622 |
| 2153 | Potato Manure | " " " " | J. H. Denise, Freehold. | 2153 |
| 2579 | Ammoniated Dissolved Bone | " " " " | J. J. Mitchell, Whippany. | 2579 |
| 2645 | Acme Fertilizer, No. 1 | C. Meyer, Jr., Maspeth L. I. | Dennis C. Crane, Roselle. | 2645 |
| 2361 | Standard Superphosphate | A. Mitchell, Linden, N. J. | Franklin Dye, Trenton. | 2361 |
| 2284 | Corn Manure | " " " | J. M. White, New Brunswick. | 2284 |
| 2283 | Potato Grower | " " " | " " " " | 2283 |
| 2447 | " and Vegetables | National Fertilizer Co., Bridgeport, Conn. | J. H. Denise, Freehold. | 2447 |
| 2372 | Lofland's Button Bone | N. J. Chemical Co., 129 S. Front St., Phila., Pa. | Franklin Dye, Trenton. | 2372 |
| 2665 | $25 Victor Ammoniated Bone | " " " " " " " | Caleb S. Ridgway, Columbus. | 2665 |
| 2435 | Yarnell's High-Grade Potato Manure | " " " " " " " | J. H. Richardson, Rio Grande. | 2435 |

# Complete Fertilizers

## Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | | Nitrogen. | | | | | Phosphoric Acid. | | | | | | | Potash. | | Chlorine. | Value of 2,000 lbs. at Station's Prices. | Selling Price of 2,000 lbs. at Factory. | Selling Price of 2,000 lbs. at Consumers' Depot. | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Soluble in Water. | Soluble in Ammonium Citrate. | Insoluble. | Total Found. | Total Guaranteed. | Available. Found. | Available. Guaranteed. | Found. | Guaranteed. | | | | | |
| 2650 | Mapes' Nitrogenized Superphos.... | 0.42 | 0.38 | 1.73 | 2.53 | 2.05 | 2.88 | 4 61 | 5.76 | 13.25 | 11.00 | 7.49 | .......... | 2.57 | 2.50 | 2.44 | 26.36 | .......... | 34.00 | 2650 |
| 2673 | " Complete, for General Use.. | 0.73 | 1.06 | 1.89 | 3.68 | 3.28 | 2.65 | 5.76 | 5.06 | 13.47 | 10.00 | 8.41 | 8.00 | 4.17 | 4.00 | 3.06 | 32.71 | .......... | 40.00 | 2673 |
| 2157 | " Fruit and Vine.................. | 0.41 | 0.56 | 1.89 | 2.86 | 1.64 | 7.30 | 2.26 | 1.12 | 10.68 | 7.00 | 9.56 | .......... | 11.15 | 11.00 | 0.44 | 37.98 | .......... | 41.00 | 2157 |
| 2620 | Miller's Potato Manure................ | ...... | 3.27 | 0.93 | 4.20 | 3.69 | 9.27 | 0.90 | 0.34 | 10.51 | .......... | 10.17 | 8.50 | 6.38 | 7.00 | 7.61 | 36.60 | 39.50 | .......... | 2620 |
| 2621 | " Standard Super. of Lime... | ...... | ...... | 1.99 | 1.99 | 2.33 | 13.44 | 0.35 | 0.12 | 13.91 | 11.50 | 13.79 | 10.00 | 2.96 | 1.50 | 2.77 | 31.62 | 30.50 | .......... | 2621 |
| 2622 | " Harvest Queen.................. | ...... | 0.14 | 1.45 | 1.59 | 0.82 | 10.58 | 1.25 | 0.41 | 12.24 | 11.50 | 11.83 | 10.00 | 2.14 | 1.50 | 4.57 | 26.57 | 24.20 | ..... ..... | 2622 |
| 2153 | " Potato Manure.................. | ...... | 1.76 | 0.86 | 2.62 | 3.69 | 9.39 | 0.25 | 0.32 | 9.96 | .......... | 9.64 | 8.50 | 9.73 | 7.00 | 10.52 | 32.88 | 39.50 | .......... | 2153 |
| 2579 | " Ammoniated Diss. Bone... | ...... | 0.17 | 2.47 | 2.64 | 1.64 | 7.62 | 4.00 | 1.85 | 13.47 | 9.50 | 11.62 | 8.00 | 1.89 | 1.50 | 4.60 | 30.06 | 27.00 | .......... | 2579 |
| 2645 | Meyer's Acme Fertilizer, No. 1...... | ...... | 2.40 | 1.03 | 3.43 | 3.69 | 3.59 | 3.55 | 1.88 | 9.02 | .......... | 7.14 | 8.00 | 8.69 | 9.00 | 5.14 | 32.21 | 40.00 | .......... | 2645 |
| 2361 | Mitchell's Standard Superphos...... | 0.30 | 0.51 | 2.08 | 2.89 | 2.05 | 8.14 | 0.78 | 1.23 | 10.15 | .......... | 8.92 | 9.00 | 2.50 | 2.50 | 0.29 | 27.27 | .......... | 36.00 | 2361 |
| 2284 | " Corn Manure.................. | 0.67 | ...... | 1.86 | 2.53 | 2.87 | 8.24 | 0 89 | 1.10 | 10.23 | .......... | 9.13 | 9.00 | 2.78 | 3.78 | 0.46 | 26.82 | .......... | .......... | 2284 |
| 2283 | " Potato Grower.............. | 0.58 | ...... | 1.86 | 2.44 | 2.87 | 8.91 | 0.01 | 0.86 | 9.78 | .......... | 8.92 | 8.00 | 3.78 | 3.78 | 0.60 | 27.13 | .......... | 45.00 | 2283 |
| 2447 | Potato and Vegetables.................. | 1.63 | ...... | 2.28 | 3.91 | 3.28 | 4.60 | 3.02 | 4.54 | 12.16 | .......... | 7.62 | 6.00 | 6.80 | 6.00 | 6.94 | 33.43 | .......... | 42.50 | 2447 |
| 2372 | Lofland.s Button Bone.................. | ..... | 1.29 | 0.54 | 1.83 | 1.23 | 7.49 | 2.16 | 2.14 | 11.79 | 11.50 | 9.65 | 10.00 | 2.86 | 2.50 | 4.23 | 25.56 | 36.00 | .......... | 2372 |
| 2665 | $25 Victor Ammoniated Bone......... | ...... | 0.14 | 1.17 | 1.31 | 1.23 | 2.65 | 2.73 | 1.95 | 7.33 | .......... | 5.38 | 6.00 | 2.30 | 2.50 | 4.75 | 16.33 | 25.00 | .......... | 2665 |
| 2435 | Yarnell's High-G'de Potato Ma'ure. | ...... | 1.56 | 2.27 | 3.83 | 3.28 | 7 25 | 0.93 | 1.71 | 9.89 | .......... | 8.18 | .......... | 6.43 | 5.00 | 6.51 | 32.54 | .......... | 45.00 | 2435 |

## Complete Fertilizers

### Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | BRAND. | MANUFACTURER. | SAMPLED BY. | Station Number. |
|---|---|---|---|---|
| 2563 | Cereal Brand | Newton & Ludlam, New York City. | Woodnutt Pettit, Salem. | 2563 |
| 2146 | Standard Ammoniated Bone Superphosphate | Orient Guano Manufacturing Co., Orient, L. I. | J. H. Denise, Freehold. | 2146 |
| 2149 | Fish and Potash | " " " " " " | " " " | 2149 |
| 2519 | Suffolk Co. Ammoniated Bone | " " " " " " | Chas. Kraus, Egg Harbor City. | 2519 |
| 2310 | Complete Manure | " " " " " " | Woodnutt Pettit, Salem. | 2310 |
| 2457 | Dried and Ground Fish Guano | James E. Otis, Tuckerton, N. J. | Geo. A. MacBean, Lakewood. | 2457 |
| 2424 | Soluble Pacific Guano | Pacific Guano Co., Boston, Mass. | I. W. Nicholson, Camden. | 2424 |
| 2640 | Special Potato Fertilizer | " " " " " | Dennis C. Crane, Roselle. | 2640 |
| 2496 | Nobsque Guano | " " " " " | D. R. Warbasse, Hunt's Mills. | 2496 |
| 2421 | Phuine | Frederick Phillips, Philadelphia, Pa. | I. W. Nicholson, Camden. | 2421 |
| 2317 | Genuine Improved Superphosphate | " " " " | Woodnutt Pettit, Salem. | 2317 |
| 2363 | Ground Bone | Preston Fertilizer Co., Green Point, L. I. | Franklin Dye, Trenton. | 2363 |
| 2364 | Potato Fertilizer | " " " " " " | " " " | 2364 |
| 2422 | Dried and Ground Fish | " " " " " " | I. W. Nicholson, Camden. | 2422 |

## Complete Fertilizers

### Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | | Nitrogen. From Nitrates. | Nitrogen. From Ammonia Salts. | Nitrogen. From Organic Matter. | Nitrogen. Total Found. | Nitrogen. Total Guaranteed. | Phosphoric Acid. Soluble in Water. | Phosphoric Acid. Soluble in Ammonium Citrate. | Phosphoric Acid. Insoluble. | Phosphoric Acid. Total Found. | Phosphoric Acid. Total Guaranteed. | Phosphoric Acid. Available. Found. | Phosphoric Acid. Available. Guaranteed. | Potash. Found. | Potash. Guaranteed. | Chlorine. | Value of 2,000 lbs. at Station's Prices. | Selling Price of 2,000 lbs. at Factory. | Selling Price of 2,000 lbs. at Consumers' Depot. | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2563 | Newton & Ludlam's Cereal Brand....... | ...... | 0.13 | 1.35 | 1.48 | 1.23 | 7.77 | 1.68 | 5.32 | 14.77 | 11.00 | 9.45 | 10.00 | 1.68 | 2.16 | 1.73 | 24.66 | ........... | 30.00 | 2563 |
| 2146 | Standard Ammon. Bone Superphos.. .. | ...... | 0.27 | 4.14 | 4.41 | 3.28 | 6.99 | 0.51 | 0.32 | 7.85 | ........... | 7.53 | 8.00 | 4.93 | 4.32 | 4.51 | 31.87 | ........... | ........... | 2146 |
| 2149 | Orient Fish and Potash........................ | ...... | 0.27 | 3.92 | 4.19 | 3.28 | 5.28 | 0.61 | 0.48 | 6.40 | ........... | 5.92 | 5.00 | 7.43 | 7.56 | 6.77 | 30.75 | ........... | ........... | 2149 |
| 2519 | " Suffolk County........................... | ...... | 0.14 | 1.31 | 1.45 | 0.98 | 7.14 | 0.87 | 1.01 | 9.02 | 9.00 | 8.01 | 8.00 | 3.29 | 2.16 | 3.27 | 21.29 | ........... | 27.00 | 2519 |
| 2310 | " Complete Manure...................... | ...... | ...... | 1.33 | 1.33 | 1.64 | 7.48 | 0.85 | 1.15 | 9.48 | 9.50 | 8.33 | 8.00 | 1.78 | 1.08 | 0.50 | 20.20 | ........... | 30.00 | 2310 |
| 2457 | Otis' Dried and Ground Fish Guano.... | ...... | 0.18 | 5.34 | 5.52 | 4.10 | 0.44 | 3.53 | 1.91 | 5.91 | 7.00 | 3.97 | ........... | 4.17 | 2.00 | 9.22 | 29.30 | 26.50 | ........... | 2457 |
| 2424 | Soluble Pacific Guano........................ | ...... | 0.17 | 2.53 | 2.70 | 2.50 | 6.56 | 1.79 | 3.96 | 12.31 | 12.00 | 8.35 | 8.00 | 2.57 | 2.10 | 2.97 | 26.87 | ........... | 33.00 | 2424 |
| 2640 | Special Potato Fertilizer...................... | ..... | 1.25 | 2.90 | 4.15 | 3.69 | 5.24 | 1.00 | 3.23 | 9.47 | 9.00 | 6.24 | 6.00 | 7.80 | 7.00 | 7.02 | 32.50 | ........... | 45.00 | 2640 |
| 2496 | Nobsque Guano ................................. | ...... | 0.12 | 1.58 | 1.70 | 1.44 | 7.33 | 1.50 | 4.44 | 13.27 | 12.00 | 8.83 | 9.00 | 1.91 | 1.75 | 2.03 | 24.36 | ........... | 30.00 | 2496 |
| 2421 | Phillips' Phuine.................................. | ...... | 0.16 | 1.79 | 1.95 | 1.64 | 6.24 | 1.21 | 3.69 | 11.14 | ........... | 7.45 | 7.00 | 2.24 | 1.08 | 0.92 | 22.76 | .......... | 35.00 | 2421 |
| 2317 | Genuine Improved Superphosphate.... | ...... | 0.10 | 1.95 | 2.05 | 1.64 | 6.82 | 1.25 | 3.85 | 11.92 | ........... | 8.07 | 8.00 | 2.61 | 2.16 | 0.69 | 25.04 | ........... | 30.00 | 2317 |
| 2363 | Preston's Ground Bone........................ | ...... | 0.26 | 3.58 | 3.84 | 4.10 | 1.02 | 3.61 | 7.27 | 11.90 | 9.00 | 4.63 | ........... | 1.87 | 3.00 | 3.50 | 26.81 | 25.00 | ........... | 2363 |
| 2364 | " Potato Fertilizer.................... | ...... | 1.08 | 2.20 | 3.28 | 3.28 | 5.60 | 2.43 | 1.31 | 9.34 | ........... | 8.03 | 6.00 | 6.00 | 10.00 | 3.13 | 30.69 | 35.00 | ........... | 2364 |
| 2422 | " Dried and Ground Fish......... | ...... | 0.59 | 3.41 | 4.00 | 4.10 | 2.76 | 3.55 | 4.27 | 10.58 | ........... | 6.31 | 6.00 | 0.58 | ........... | 1.66 | 27.16 | 26.00 | ........... | 2422 |

## Complete Fertilizers

### Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | BRAND. | MANUFACTURER. | SAMPLED BY. | Station Number. |
|---|---|---|---|---|
| 2458 | Ammoniated Bone Superphosphate | Preston Fertilizer Co., Green Point, L. I. | Geo. A. MacBean, Lakewood. | 2458 |
| 2676 | Blood and Bone Manure | Read & Co., 88 Wall St., N. Y. | A. J. Thompson, Readington. | 2676 |
| 2680 | Farmers' Friend for All Crops | " " " " | " " " | 2680 |
| 2677 | High-Grade Farmers' Friend | " " " " | " " " | 2677 |
| 2658 | Cereal Bone Phosphate | J. Richmond, 147 S. Front St., Phila., Pa. | J. S. Ten Eyck, North Branch. | 2658 |
| 2479 | Potato and Fruit Tree | " " " " " | Jas. C. Griscom, Woodbury. | 2479 |
| 2482 | High-Grade Excelsior | " " " " " | " " " | 2482 |
| 2483 | Ammoniated Bone Superphosphate | " " " " " | " " " | 2483 |
| 2657 | Azotized Bone Superphosphate | " " " " " | J. S. Ten Eyck, North Branch. | 2657 |
| 2369 | Swift and Sure | R. Savidge, Mount Rose, N. J. | Franklin Dye, Trenton. | 2369 |
| 2449 | Sure Growth | Scott Fertilizer Co., Elkton, Md. | J. H. Denise, Freehold. | 2449 |
| 2379 | Union High-Grade Fertilizer, No. II.* | Sharpless & Carpenter, 114 S. Delaware Ave., Phila., Pa. | I. W. Nicholson, Camden. | 2379 |
| 2381 | Pure Dissolved Bone* | " " " " " " " | " " " | 2381 |
| 2433 | Soluble Tampico Guano | " " " " " " " | J. H. Richardson, Rio Grande. | 2433 |
| 2300 | No. 1 Bone Phosphate | " " " " " " " | Geo. A. MacBean, Lakewood. | 2300 |

* Manufactured for the Fruit Growers' Union, Hammonton, N. J.

## Complete Fertilizers

### Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | | Nitrogen. | | | | | Phosphoric Acid. | | | | | Available. | | Potash. | | Chlorine. | Value of 2,000 lbs. at Station's Prices. | Selling Price of 2,000 lbs. at Factory. | Selling Price of 2,000 lbs. at Consumers' Depot. | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Soluble in Water. | Soluble in Ammonium Citrate. | Insoluble. | Total Found. | Total Guaranteed. | Found. | Guaranteed. | Found. | Guaranteed. | | | | | |
| 2458 | Preston's Ammon. Bone Superphos.. | ...... | 0.40 | 2.73 | 3.13 | 2.46 | 4 41 | 3.36 | 3.92 | 11.69 | ........... | 7.77 | 9.00 | 2.96 | 2.00 | 0.93 | 28.15 | 27.00 | ........... | 2458 |
| 2676 | Blood and Bone Manure.................... | ...... | ...... | 1.66 | 1.66 | 0.82 | 5.76 | 2.77 | 3.76 | 12.29 | ........... | 8.53 | 7.00 | 1.45 | 1.00 | 1.51 | 22.95 | ........... | 25.00 | 2676 |
| 2680 | Farmers' Friend for All Crops........... | ...... | 0.16 | 1.92 | 2.08 | 2.05 | 7.24 | 1.77 | 2.11 | 11.12 | ........... | 9.01 | 9.00 | 2.02 | 2.16 | 3.14 | 24.68 | ..... ...... | 33.00 | 2680 |
| 2677 | High-Grade Farmers' Friend.... ....... | ...... | 0.12 | 3.43 | 3.55 | 3.28 | 3.46 | 1.69 | 2.40 | 7.55 | ........ . | 5.15 | 5.00 | 10.53 | 10.00 | 9.65 | 30.37 | ........... | 40.00 | 2677 |
| 2658 | Richmond's Cereal Bone Phosphate. | ...... | ...... | 1.51 | 1.51 | 0.82 | 4.32 | 2.93 | 2.63 | 9.88 | 7.00 | 7.25 | 6.00 | 1.45 | 0.54 | 1.39 | 19.70 | ........... | 25.00 | 2658 |
| 2479 | " Potato and Fruit Tree... | ...... | ...... | 1.67 | 1.67 | 0.82 | 5.15 | 1.98 | 2.09 | 9.22 | ........... | 7.13 | 6.00 | 7.20 | 4.86 | 8.61 | 24.63 | ........... | 28.00 | 2479 |
| 2482 | " High-Grade Excelsior... | ...... | 2.21 | 1.24 | 3.45 | 3.28 | 9.68 | 0.87 | 1 54 | 12.09 | 11.00 | 10.55 | 10.00 | 4.71 | 2.70 | 4.60 | 33.88 | ........... | 40.00 | 2482 |
| 2483 | " Ammon. Bone Super..... | ...... | 0.22 | 2.15 | 2.37 | 2.05 | 8 83 | 0.84 | 1.88 | 11.55 | 10.00 | 9.67 | 9.00 | 1.83 | 1.08 | 1.98 | 26.03 | ........... | 32.00 | 2483 |
| 2657 | " Azotized Bone Super..... | ...... | 0.17 | 1.85 | 2.02 | 1.23 | 6.01 | 1.94 | 3.40 | 11.35 | 9.00 | 7.95 | 8.00 | 2.57 | 1.62 | 2.62 | 23.65 | ........... | 30.00 | 2657 |
| 2369 | Savidge's Swift and Sure................. | ...... | 0.25 | 1.35 | 1.60 | 1.64 | 5.33 | 2.85 | 1.38 | 9.56 | 10.00 | 8.18 | 8.00 | 2.82 | 1.50 | 5.67 | 21.66 | ........... | 26.00 | 2369 |
| 2449 | Scott's Sure Growth... ....... ............... | ...... | ...... | 2.22 | 2.22 | 3.28 | 8.67 | 3.27 | 1.92 | 13.86 | 10.00 | 11.94 | ........... | 7.49 | 5.00 | 8.00 | 33.95 | ........... | 36.00 | 2449 |
| 2379 | Union High-Grade Fertilizer, No. II. | ...... | 1.88 | 1.26 | 3.14 | 3.28 | 7.07 | 1.17 | 1.60 | 9.84 | ........... | 8.24 | 7.00 | 9.06 | 7.00 | 10.56 | 32.58 | 36.00 | ........... | 2379 |
| 2381 | Pure Dissolved Bone......................... | ...... | ...... | 2.45 | 2.45 | 1.64 | 7.00 | 4.15 | 6 25 | 17.40 | ........... | 11.15 | 12.00 | ........... | .......... | ......... | 29.68 | 32.00 | ........... | 2381 |
| 2433 | Soluble Tampico Guano..................... | ...... | 0.26 | 2.61 | 2.87 | 2.87 | 6.05 | 0.86 | 2.06 | 8.97 | ........... | 6.91 | 8.00 | 5.54 | 5.50 | 5.40 | 26.53 | ........... | ........... | 2433 |
| 2300 | No. 1 Bone Phosphate....................... | ...... | 0.10 | 1.69 | 1.79 | 1.23 | 4.70 | 1.87 | 3.85 | 10.42 | ........... | 6.57 | 6.50 | 2.52 | 2.00 | 5.65 | 21.23 | ........... | 25.00 | 2300 |

## Complete Fertilizers

### Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | BRAND. | MANUFACTURER. | SAMPLED BY. | Station Number. |
|---|---|---|---|---|
| 2440 | Potato, Truck and Tobacco | John I. Smith, Trenton, N. J. | Franklin Dye, Trenton. | 2440 |
| 2681 | Bone Phosphate | " " " " | A. J. Thompson, Readington. | 2681 |
| 2448 | Swift Sure Superphosphate | M. L. Shoemaker & Co., Philadelphia, Pa. | J. H. Denise, Freehold. | 2448 |
| 2472 | High-Grade Ammoniated Bone Superphosphate | Stearns Fertilizer Co., N. Y. City. | J. B. Eckerson, River Vale. | 2472 |
| 2418 | No 1 Peruvian Guano | | I. W. Nicholson, Camden. | 2418 |
| 2425 | Lobos Guano | | " " " | 2425 |
| 2426 | All Crops Fertilizer | Taylor Bros., Camden, N. J. | " " " | 2426 |
| 2271 | Ammoniated Dissolved Bone and Potash | John Taylor & Co., Trenton, N. J. | Franklin Dye, Trenton. | 2271 |
| 2450 | Corn and Truck | " " " " " | J. H. Denise, Freehold. | 2450 |
| 2564 | Potatoes, Truck and Tobacco | " " " " " | Woodnutt Pettit, Salem. | 2564 |
| 2386 | Farmers' Choice Bone Phosphate | I. P. Thomas & Son, Phila., Pa. | I. W. Nicholson, Camden. | 2386 |
| 2661 | Peach Tree Fertilizer | " " " " " | J. S. Ten Eyck, North Branch. | 2661 |
| 2443 | Normal Bone Phosphate | " " " " " | Franklin Dye, Trenton. | 2443 |
| 2525 | XX Potato Manure | " " " " " | Chas. Kraus, Egg Harbor City. | 2525 |
| 2526 | Fish Guano | " " " " " | " " " " " | 2526 |

# Complete Fertilizers

## Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | | Nitrogen. | | | | | Phosphoric Acid. | | | | | | | Potash. | | Chlorine. | Value of 2,000 lbs. at Station's Prices. | Selling Price of 2,000 lbs. at Factory. | Selling Price of 2,000 lbs. at Consumers' Depot. | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Soluble in Water. | Soluble in Ammonium Citrate. | Insoluble. | Total Found. | Total Guaranteed. | Available. Found. | Available. Guaranteed. | Found. | Guaranteed. | | | | | |
| 2440 | Smith's Potato, Truck & Tobacco... | 0.91 | 0.22 | 2.56 | 3.69 | 3.28 | 4.80 | 3.86 | 2.09 | 10.75 | 11.00 | 8.66 | 9.00 | 11.26 | 10.00 | 10.63 | 36.81 | ........... | 45.00 | 2440 |
| 2681 | " Bone Phosphate................ | ...... | 0.11 | 2.22 | 2.33 | 1.64 | 5.61 | 2.44 | 1.16 | 9.21 | ........... | 8.05 | 10.00 | 3.71 | 2.00 | 6.88 | 24.88 | ........... | 31.00 | 2681 |
| 2448 | Shoemaker's Swift Sure Superphos. | 0.51 | ...... | 2.52 | 3.03 | 2.46 | 8.33 | 3.47 | 3.71 | 15.51 | 14.00 | 11.80 | 9.00 | 4.21 | 2.16 | 4.11 | 34.64 | 35.00 | ........... | 2448 |
| 2472 | Stearns' High-Grade Ammoniated. | 0.28 | ...... | 2.58 | 2.86 | 1.64 | 4.58 | 2.99 | 4.26 | 11.82 | ........... | 7.57 | 8.00 | 3.67 | 3.00 | 4.78 | 27.20 | ........... | 38.00 | 2472 |
| 2418 | No. 1 Peruvian Guano................ | 0.11 | 5.62 | 1.80 | 7.53 | ......... | 7.10 | 2.73 | 4.81 | 14.64 | ........... | 9.83 | ........... | 3.04 | ........... | 4.50 | 47.16 | 59.00 | ........... | 2418 |
| 2425 | Lobos Guano................................ | 0.12 | 2.37 | 1.37 | 3.86 | ......... | 3.12 | 4.71 | 15.36 | 23.19 | ........... | 7.83 | ........... | 5.05 | ........... | 2.74 | 39.60 | 43.00 | ........... | 2425 |
| 2426 | Taylor Bros.' All Crops Fertilizer... | ...... | ...... | 0.98 | 0.98 | 0.82 | 6.87 | 1.24 | 2.98 | 11.09 | 9.00 | 8.11 | 7.00 | 1.68 | 1.50 | 3.95 | 19.42 | 25.00 | ........... | 2426 |
| 2271 | Taylor's Ammoniated Dis. Bone ... | ...... | 0.50 | 0.89 | 1.39 | 1.23 | 5.07 | 2.31 | 3.80 | 11.18 | 10.00 | 7.38 | 8.00 | 3.88 | 2.00 | 6.65 | 22.26 | 25.00 | ........... | 2271 |
| 2450 | " Corn and Truck................ | 0.35 | 0.39 | 1.67 | 2.41 | 2.46 | 6.72 | 1.85 | 3.53 | 12.10 | 13.00 | 8.57 | 9.00 | 5.33 | 5.00 | 5.44 | 28.36 | 35.00 | ........... | 2450 |
| 2564 | " Potato, Truck & Tobacco. | ...... | 0.92 | 2.36 | 3.28 | 3.28 | 5.88 | 2.08 | 3.85 | 11.81 | 13.00 | 7.96 | 9.00 | 9.63 | 10.00 | 8.74 | 34.25 | 45.00 | ........... | 2564 |
| 2386 | Thomas' Farmers' Ch. Bone Phos.. | ...... | ...... | 1.33 | 1.33 | 1.23 | 6.87 | 1.05 | 3.62 | 11.54 | 10.00 | 7.92 | 8.00 | 4.19 | 2.00 | 4.41 | 22.79 | ........... | 32.00 | 2386 |
| 2661 | " Peach Tree Fertilizer...... | ...... | ...... | 1.26 | 1.26 | 1.03 | 3.92 | 4.40 | 3.75 | 12.07 | 9.50 | 8.32 | 7.50 | 7.80 | 8.00 | 3.09 | 27.53 | ........... | 32.00 | 2661 |
| 2443 | " Normal Bone Phosphate. | ...... | ...... | 0.71 | 0.71 | 0.82 | 7.48 | 2.16 | 3.56 | 13.20 | 9.00 | 9.64 | 7.00 | 1.04 | 1.50 | 0.91 | 20.74 | ........... | 26.00 | 2443 |
| 2525 | " XX Potato Manure......... | ...... | 0.12 | 1.62 | 1.74 | 1.64 | 2.55 | 4.65 | 4.07 | 11.27 | 10.50 | 7.20 | 7.50 | 8.75 | 8.00 | 3.60 | 28.49 | ........... | 40.00 | 2525 |
| 2526 | " Fish Guano...................... | ...... | ...... | 1.15 | 1.15 | 1.23 | 8.51 | 1.27 | 2.33 | 12.11 | 10.00 | 9.78 | 8.00 | 2.01 | 2.00 | 4.37 | 22.79 | ........... | 35.00 | 2526 |

## Complete Fertilizers

### Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | BRAND. | MANUFACTURER. | SAMPLED BY. | Station Number. |
|---|---|---|---|---|
| 2325 | Star Bone Guano | J. E Tygert & Co., Philadelphia, Pa. | Woodnutt Pettit, Salem. | 2325 |
| 2431 | Truckers' Triumph | " " " " " | J. H. Richardson, Rio Grande. | 2431 |
| 2527 | Star Bone Phosphate | " " " " " | Chas. Kraus, Egg Harbor City. | 2527 |
| 2583 | $55 Mineral Fertilizer | Jeptha A. Wagener, Holtsville, N. Y. | J. J. Mitchell, Whippany. | 2583 |
| 2451 | Blood Phosphate | Wando Phosphate Co., Charleston, S. C. | J. H. Denise, Freehold. | 2451 |
| 2684 | Favorite | J. Wenderoth & Sons, Camden, N. J. | I. W. Nicholson, Camden. | 2684 |
| 2686 | Potato Fertilizer | " " " " | " " " | 2686 |
| 2685 | Equine | " " " " | " " " | 2685 |
| 2292 | Royal Bone | Williams & Clark Co., 101 Pearl Street, N. Y. | J. M. White, New Brunswick. | 2292 |
| 2330 | High-Grade Special Potato | " " " " " " | J. C. Griscom, Woodbury. | 2330 |
| 2356 | Americus Ammoniated Bone Superphosphate | " " " " " " | Dennis C. Crane, Roselle. | 2356 |
| 2291 | Americus | " " " " " " | J. M. White, New Brunswick. | 2291 |
| 2565 | Potato Phosphate | " " " " " " | Woodnutt Pettit, Salem. | 2565 |
| 2691 | Economical Bone Fertilizer | Wilkinson & Co., 52–54 William Street, N. Y. | Samuel J. Hixson, Bridgeville. | 2691 |

## Complete Fertilizers

### Furnishing Nitrogen, Phosphoric Acid and Potash.

| Station Number. | | Nitrogen. | | | | | Phosphoric Acid. | | | | | | | Potash. | | | | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Available. | | | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Soluble in Water. | Soluble in Ammonium Citrate. | Insoluble. | Total Found. | Total Guaranteed. | Found. | Guaranteed. | Found. | Guaranteed. | Chlorine. | Value of 2,000 lbs. at Station's Prices. | Selling Price of 2,000 lbs. at Factory. | Selling Price of 2,000 lbs. at Consumers' Depot. | |
| 2325 | Tygert's Star Bone Guano | ...... | ...... | 2.24 | 2.24 | 2.25 | 5.79 | 1.06 | 2.55 | 9.40 | 9.50 | 6.85 | 7.50 | 2.61 | 3.50 | 4.21 | 22.55 | ..... ...... | 25.00 | 2325 |
| 2431 | " Truckers' Triumph | ...... | 0.15 | 3.44 | 3.59 | 3.69 | 6.39 | 0.97 | 2.33 | 9.69 | 8.50 | 7.36 | 7.00 | 7.64 | 7.00 | 6.17 | 32.23 | ........... | 40.00 | 2431 |
| 2527 | " Star Bone Phosphate | ...... | 0.13 | 1.79 | 1.92 | 1.85 | 7.29 | 1.24 | 2.59 | 11.12 | 10.50 | 8.53 | 8.50 | 2.44 | 2.50 | 3.87 | 23.63 | ........... | 29.00 | 2527 |
| 2583 | Wagener's Mineral Fertilizer | 0.25 | ...... | 0.80 | 1.05 | 4.92 | 0.61 | 1.01 | 0.26 | 2.88 | ........... | 2.62 | 12.00 | 0.21 | 6.00 | 0.24 | 6.38 | ........... | 55.00 | 2583 |
| 2451 | Wando Blood Phosphate | ...... | 0.34 | 2.08 | 2.42 | 2.05 | 7.87 | 0.63 | 4.45 | 12.95 | 9.50 | 8.50 | 9.00 | 1.53 | 1.25 | 1.21 | 25.62 | 32.00 | ........... | 2451 |
| 2684 | Wenderoth's Favorite | ...... | 0.11 | 6.61 | 6.72 | 5.74 | 0.69 | 3.06 | 6.27 | 10.02 | 11.00 | 3.75 | ........... | 5.68 | 4.00 | 5.79 | 38.12 | 36.10 | ........... | 2684 |
| 2686 | " Potato Fertilizer | ...... | 0.13 | 3.16 | 3.29 | 3.28 | 5.91 | 1.22 | 3.20 | 10.33 | 9.00 | 7.13 | 7.00 | 4.31 | 4.00 | 4.13 | 28.51 | 33.25 | ........... | 2686 |
| 2685 | " Equine | ...... | 0.11 | 3.65 | 3.76 | 3.28 | 6.15 | 1.59 | 3.14 | 10.88 | 10.00 | 7.74 | 8.00 | 0.30 | ......... | 0.24 | 26.96 | 30.40 | ........... | 2685 |
| 2292 | Williams & Clark's Royal Bone | ...... | ...... | 1.67 | 1.67 | 0.82 | 3.84 | 0.71 | 3.90 | 8.45 | 8.00 | 4.55 | 7.00 | 1.87 | 2.00 | 0.42 | 17.05 | ........... | ........... | 2292 |
| 2330 | High-Grade Special Potato | ...... | 2.00 | 1.83 | 3.83 | 3.28 | 6.99 | 0.58 | 0.78 | 8.35 | 7.00 | 7.57 | 6.00 | 8.25 | 8.00 | 0.50 | 34.53 | ........... | 42.00 | 2330 |
| 2356 | Ammoniated Bone Superphosphate | ...... | 1.06 | 1.70 | 2.76 | 2.46 | 9.88 | 0.50 | 1.15 | 11.53 | 10.00 | 10.38 | 9.00 | 3.12 | 2.00 | 0.22 | 29.98 | ........... | 35.00 | 2356 |
| 2291 | Williams & Clark, Americus | ...... | 1.60 | 1.96 | 3.56 | 2.46 | 7.28 | 0.33 | 0.25 | 7.86 | ........... | 7.61 | 9.00 | 7.87 | 5.00 | 4.70 | 31.90 | ........... | ........... | 2291 |
| 2565 | " " Potato Phosphate | ...... | 1.00 | 1.88 | 2.88 | 2.46 | 7.37 | 0.85 | 0.79 | 9.01 | ........... | 8.22 | 7.00 | 6.29 | 6.00 | 0.59 | 30.42 | ........... | 40.00 | 2565 |
| 2691 | Wilkinson's Economical Bone Fertilizer | ...... | 1.04 | 0.12 | 1.16 | 1.23 | 3.60 | 1.74 | 2.63 | 7.97 | 6.00 | 5.34 | ........... | 2.87 | 1.08 | 6.86 | 16.62 | ........... | 32.00 | 2691 |

## Ground Bone

### Furnishing Nitrogen and Insoluble Phosphoric Acid.

| Station Number. | BRAND. | MANUFACTURER. | SAMPLED BY. | Station Number. |
|---|---|---|---|---|
| 2599 | Pure Raw Bone | Wm. P. Adams, 218 Front St, N. Y. | J. B. Eckerson, River Vale. | 2599 |
| 2551 | " Ground Bone—Fine | Brands & Reed, Belvidere, N. J. | Sam'l J. Hixson, Bridgeville. | 2551 |
| 2552 | " " " —Coarse | " " " " | " " " | 2552 |
| 2648 | " Bone Dust | Peter Cooper's Glue Factory, 17 Burling Slip, N. Y. | J. S. Ten Eyck, North Branch. | 2648 |
| 2570 | " Ground Bone | Crocker Fertilizer Co., 60 Pearl St., Buffalo, N. Y. | J. J. Mitchell, Whippany. | 2570 |
| 2654 | Celebrated Ground Bone | Lister's Agr. Chem. Works, Newark, N. J. | J. S. Ten Eyck, North Branch. | 2654 |
| 2653 | Crescent Bone | " " " " " " | " " " " | 2653 |
| 2366 | Ground Bone | H. S. Miller & Co., Newark, N. J. | Franklin Dye, Trenton. | 2366 |
| 2687 | Coarse Bone | " " " " " | Assistant Chemist of Station. | 2687 |
| 2688 | Medium Bone | " " " " " | " " " " | 2688 |
| 2689 | Fine Bone | " " " " " | " " " " | 2689 |
| 2548 | Ground Bone | Mapes' F. & P. Guano Co., 158 Front St., N. Y. | A. J. Thompson, Readington. | 2548 |
| 2370 | " " | Pumyea & Perrine, Hightstown, N. J. | Franklin Dye, Trenton. | 2370 |
| 2382 | Pure Bone Meal* | Sharpless & Carpenter, 114 S. Delaware Ave., Phila., Pa. | I. W. Nicholson, Camden. | 2382 |
| 2322 | Swift Sure Bone Meal | M. L. Shoemaker & Co., Philadelphia, Pa. | Woodnutt Pettit, Salem. | 2322 |
| 2442 | Raw Bone Meal | I. P. Thomas & Son, Philadelphia, Pa. | Franklin Dye, Trenton. | 2142 |
| 2683 | Pure Ground Bone | J. Wenderoth & Sons, Camden, N. J. | I. W. Nicholson, Camden. | 2683 |
| 2359 | Americus Pure Bone Meal | Williams, Clark & Co., 101 Pearl St., N. Y. | Dennis C. Crane, Roselle. | 2359 |
| 2581 | Pure Bone Meal | " " " " " " | J. J. Mitchell, Whippany. | 2581 |

* Manufactured for the Fruit Growers' Union, Hammonton, N. J.

## Ground Bone

### Furnishing Nitrogen and Insoluble Phosphoric Acid.

| Station Number. | | Mechanical Analysis. Finer than 1/50 inch. | Finer than 1/25 inch. | Finer than 1/12 inch. | Finer than 1/6 inch. | Coarser than 1/6 inch. | Chemical Analysis. Nitrogen. | Phosphoric Acid. | Value of 2,000 lbs. at Station's Prices. | Selling Price of 2,000 lbs. | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2599 | William P. Adams' Pure Raw Bone | 52. | 46. | 2. | ...... | ...... | 3.95 | 20.43 | 38.24 | 38.00 | 2599 |
| 2551 | Brands & Reed's Pure Ground Bone—Fine | 24. | 60. | 16. | ...... | ...... | 3.84 | 17.10 | 31.12 | 36.00 | 2551 |
| 2552 | " " " " " —Coarse | 12. | 29. | 30. | 25. | 4. | 4.14 | 18.61 | 28.90 | 32.00 | 2552 |
| 2618 | Peter Cooper's Pure Bone Dust | 44. | 20. | 16. | 20. | ...... | 1.62 | 31.72 | 41.62 | 30.00 | 2618 |
| 2570 | Crocker's Pure Ground Bone | 55. | 24. | 16. | 5. | ...... | 4.51 | 23.55 | 42.51 | 42.00 | 2570 |
| 2654 | Lister's Celebrated Ground Bone | 26. | 24. | 19. | 28. | 3. | 3.24 | 13.69 | 22.74 | 29.00 | 2654 |
| 2653 | " Crescent Bone | 35. | 26. | 20. | 17. | 2. | 2.93 | 12.92 | 22.51 | 27.00 | 2653 |
| 2366 | H. S. Miller's Ground Bone | 38. | 33. | 29. | ...... | ...... | 3.70 | 24.06 | 39.38 | 35.00 | 2366 |
| 2687 | " " Coarse Bone | ...... | ...... | ...... | 80. | 20. | 4.26 | 24.50 | 26.84 | 33.50 | 2687 |
| 2688 | " " Medium Bone | 21. | 43. | 29. | 7. | ...... | 3.44 | 25.46 | 38.17 | 33.50 | 2688 |
| 2689 | " " Fine Bone | 100. | ...... | ...... | ...... | ...... | 2.05 | 27.52 | 45.30 | 35.00 | 2689 |
| 2518 | Mapes' Ground Bone | 32. | 23. | 24. | 21. | ...... | 2.77 | 27.25 | 37.81 | 36.00 | 2518 |
| 2370 | Pumyea & Perrine's Ground Bone | 46. | 31. | 23. | ...... | ...... | 3.75 | 24.24 | 40.76 | 30.00 | 2370 |
| 2382 | Sharpless & Carpenter's Pure Bone Meal | 48. | 37. | 15. | ...... | ...... | 4.03 | 20.71 | 37.76 | 32.00 | 2382 |
| 2322 | M. L. Shoemaker's Swift Sure Bone Meal | 49. | 38. | 13. | ...... | ...... | 6.29 | 20.24 | 43.84 | 35.00 | 2322 |
| 2442 | I. P. Thomas' Raw Bone Meal | 55. | 22. | 13. | 8. | 2. | 2.28 | 21.77 | 37.27 | 30.00 | 2442 |
| 2683 | Wenderoth's Pure Ground Bone | 17. | 14. | 21. | 44. | 4. | 4.14 | 23.07 | 32.12 | 34.00 | 2683 |
| 2359 | Williams, Clark & Co.'s Americus Pure Bone Meal | 45. | 26. | 19. | 10. | ...... | 3.05 | 23.78 | 37.17 | 37.50 | 2359 |
| 2581 | " " " Pure Bone Meal | 41. | 22. | 20. | 17. | ...... | 3.52 | 22.02 | 35.13 | 36.00 | 2581 |

## Miscellaneous Samples.

### Dissolved Bones, Dried Fish, Superphosphates with Potash, and Plain Superphosphates.

| Station Number. | BRAND. | MANUFACTURER. | SAMPLED BY. | Station Number. |
|---|---|---|---|---|
| 2294 | $25 Phosphate | Baugh & Sons Co., Philadelphia, Pa. | Geo. A. MacBean, Lakewood. | 2294 |
| 2634 | Dissolved Animal Bones | Dambmann Bros. & Co., Baltimore, Md. | J. B. Eckerson, River Vale. | 2634 |
| 2690 | " Bone | H. S. Miller & Co., Newark, N. J. | Assistant Chemist of Station. | 2690 |
| 2679 | Ammoniated Dissolved Bone | Read & Co., 88 Wall St., N. Y. | A. J. Thompson, Readington. | 2679 |
| 2427 | Pure Fish Guano | Taylor Bros., Camden, N. J. | I. W. Nicholson, Camden. | 2427 |
| 2593 | Soluble Phosphate and Potash | Allentown Manufacturing Co., Allentown, Pa. | D. R. Warbasse, Hunt's Mills. | 2593 |
| 2169 | Superphosphate with Potash | Bowker Fertilizer Co., 27 Beaver St., N. Y. | J. M. White, New Brunswick. | 2169 |
| 2567 | Cotton Hull Ashes | .................... | Woodnutt Pettit, Salem. | 2567 |
| 2374 | Soluble Bone and Potash | N. J. Chemical Co., 129 S. Front St., Phila., Pa. | Franklin Dye, Trenton. | 2374 |
| 2678 | Alkaline Bone | Read & Co., 88 Wall St., N. Y. | A. J. Thompson, Readington. | 2678 |
| 2480 | Soluble Bone Phosphate, | J. Richmond, 147 S. Front St., Phila., Pa. | J. C. Griscom, Woodbury. | 2480 |
| 2663 | Philadelphia Standard Phosphate | John T. Baily & Co., Philadelphia, Pa. | Caleb S. Ridgway, Columbus. | 2663 |
| 2664 | Acidulated Phosphate | N. J. Chemical Co., 129 S. Front St., Phila., Pa. | " " " | 2664 |
| 2307 | Phosphate Meal | Paul Weidinger, 76 Pine St., N. Y. | J. M. White, New Brunswick. | 2307 |

## Miscellaneous Samples.

### Dissolved Bones, Dried Fish, Superphosphates with Potash, and Plain Superphosphates.

| Station Number. | | Nitrogen. | | Phosphoric Acid. | | | | | | | Potash. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Available. | | | | | | | | |
| | | Found. | Guaranteed. | Soluble in Water. | Soluble in Ammonium Citrate. | Insoluble. | Total Found. | Total Guaranteed. | Found, | Guaranteed. | Found. | Guaranteed. | Chlorine. | Value of 2,000 lbs. at Station's Prices. | Selling Price of 2,000 lbs. at Factory. | Selling Price of 2,000 lbs. at Consumers' Depot. | Station Number. |
| 2294 | Baugh's $25 Phosphate | 2.04 | 2.05 | 6.27 | 0.60 | 4.36 | 11.23 | | 6.87 | 7.00 | | | | 20.75 | | 25.00 | 2294 |
| 2634 | Dambmann's Dissolved Animal Bones | 2.41 | 2.05 | 9.09 | 6.12 | 1.32 | 16.53 | | 15.21 | 12.00 | | | | 33.56 | 32.00 | | 2634 |
| 2690 | Miller's Dissolved Bone | 2.07 | | 5.47 | 7.67 | 5.57 | 18.71 | | 13.14 | | | | | 31.61 | 32.50 | | 2690 |
| 2679 | Read's Ammoniated Dissolved Bone | 2.02 | 1.64 | 5.20 | 5.45 | 5.47 | 16.12 | | 10.65 | 12.00 | | | | 27.39 | | 30.00 | 2679 |
| 2427 | Taylor Bros.' Pure Fish Guano | 8.54 | 8.20 | 1.05 | 3.49 | 2.42 | 6.96 | 7.00 | 4.54 | | | | | 38.60 | 37.00 | | 2427 |
| 2593 | Soluble Phosphate and Potash | | | 6.68 | 1.99 | 2.91 | 11.58 | 10.00 | 8.67 | 9.00 | 3.15 | 3.00 | 8.38 | 18.30 | 23.00 | | 2593 |
| 2169 | Bowker's Superphosphate with Potash | | | 11.48 | 2.24 | 3.13 | 16.85 | | 13.72 | | 1.06 | | 1.17 | 24.73 | | 23.00 | 2169 |
| 2567 | Cotton Hull Ashes | | | 1.48 | 7.12 | 1.39 | 9.99 | | 8.60 | | 25.74 | | 0.15 | 42.85 | | 30.00 | 2567 |
| 2374 | Soluble Bone and Potash | | | 8.38 | 1.18 | 2.86 | 12.42 | | 9.56 | | 1.53 | | 4.06 | 18.32 | | 25.00 | 2374 |
| 2678 | Read's Alkaline Bone | | | 6.78 | 2.22 | 1.62 | 10.62 | | 9.00 | 10.00 | 3.01 | 2.16 | 2.34 | 17.93 | | 25.00 | 2678 |
| 2480 | Richmond's Soluble Bone Phosphate | | | 7.74 | 1.59 | 3.50 | 12.83 | 9.00 | 9.33 | 8.00 | 1.08 | 1.08 | 2.30 | 17.94 | | 18.00 | 2480 |
| 2663 | Philadelphia Standard Phosphate | | | 9.43 | 2.19 | 4.33 | 15.95 | | 11.62 | 12.00 | | | | | | 20.00 | 2663 |
| 2664 | Acidulated Phosphate | | | 9.60 | 1.58 | 3.28 | 14.46 | | 11.18 | 13.00 | | | | | 15.00 | | 2664 |
| 2307 | Weidinger's Phosphate Meal | | | | 6.87 | 12.35 | 19.22 | | 6.87 | | | | | | 13.50 | | 2307 |

## III.
## AGRICULTURAL RELATIONS OF FERTILIZERS.

The discussions in the previous chapters are devoted exclusively to the commercial relations of fertilizers, and are mainly valuable in indicating the sources from which plant-food is secured, the work of the manufacturers in preparing it for market, and a comparison of actual commercial values as demanded by the different firms represented. This work is also useful in showing the dependence placed upon commercial fertilizers by the farmers of New Jersey, but must not be taken as a guide to their profitable use. It does not necessarily follow that a mixture of nitrogen, phosphoric acid and potash, which costs and is actually worth $10, will produce on the soil upon which it is applied, such an increase as to admit of a profit to the farmer who makes such an investment. The agricultural value of a fertilizer must be secured from data of a different character. In order that a knowledge of the commercial values of fertilizers may serve as a sure guide to their agricultural value, it is essential to know, 1st, the soil in all its relations to plant-food, texture, moisture, &c., and, 2d, how to control all the conditions which can influence the crop. This has been acknowledged from the beginning of agricultural investigation, and has led to various methods of experimentation for the purpose of determining, 1st, those principles in the nutrition of plants which govern the action of the various forms and kinds of plant-food, both applied and present in the soil, and, 2d, the means by which uncontrolled conditions may be limited.

This field of scientific research is wide, and individual experiments, from the nature of the work, are usually confined to groups of specific and definite questions. The principal methods used in attempts to solve these questions are, 1st, Field Experiments, and, 2d, Pot Experiments. The relative value of these two methods of investigation is at the present time not entirely settled. Both methods, however, have supplemented each other to a considerable extent, and by their aid many scientific facts have been demonstrated, and hence much valuable data secured, capable of application by the practical farmer. The field of agricultural experimentation is, nevertheless, still practically unlimited.

The equipment of this Station has rendered field experiments with fertilizers the only feasible method to be followed. Since 1881 these experiments have numbered more than sixty—have been distributed upon the radically different soils of the State, and have included all the staple farm crops grown in New Jersey. In this work several distinct ends have been kept in view, and detailed statements of results have been published from time to time in previous reports of this Station. Definite conclusions thus far reached can be grouped as follows:

*1. Profitable returns cannot always be secured, even when the highest grades of fertilizers are used throughout an entire rotation.*

*2. Fertilizers, when used upon suitable soils, secure immediate profits and also materially benefit the land.*

The experiment on millet, by Mr. Arnold, and that on peach trees, by Mr. Dayton, were planned to test roughly the effects of plant-food upon certain soils and crops. One experiment carried out at the College Farm, and four experiments by farmers in Salem county, were planned to test the relative value of phosphoric acid derived from different sources. An experiment to test the uniformity of soil on unmanured plots is also continued and the results of this year recorded.

## FIELD EXPERIMENTS BY MR. A. P. ARNOLD.

VINELAND, CUMBERLAND COUNTY.

In 1882 Mr. Arnold began a series of field experiments under the Station's directions, to determine:

*I. The effect of barn-yard manure upon a rotation of crops, compared with the effects of the leading elements of plant-food used separately and in combinations.*

*II. The financial results which follow the use of commercial fertilizers.*

A description of this farm and its management was given in the annual report of this Station for 1886; it indicated that dairying was not followed to any marked extent and that a very limited supply of manure was produced; that fertilizers were used successfully and that the tendency at present was against complete manures and in favor of acid phosphates and potash salts.

It was shown that a four-year rotation was followed, viz., corn, sweet potatoes, clover and millet, and clover; the object being to keep the ground in good condition for the potatoes, from which the profits of the rotation were secured, the income from this crop being equal to that received from the other three combined.

The field was selected for this work in 1882; at that time it was in blackberries. It was prepared for corn in the usual manner, and eleven plots, each one-tenth of an acre in area, were staked off in a favorable location. The kinds and quantities of plant-food used in 1882 upon each plot can be learned from a following table. During the succeeding years of the rotation every crop was fertilized, but no changes of any kind were made in the original plan. Plot 11, therefore, received during the rotation *eighty tons* of stable manure per acre. In like manner, plot 4 received *six hundred pounds* of muriate of potash, plot 3 *fourteen hundred pounds* of bone-black superphosphate, plot 9 *twenty-six hundred pounds* of a high-grade potato fertilizer per acre, &c., in each case one-quarter of the above weights having been used broadcast annually.

At the close of the first rotation the following conclusions were reached:

1. The total market value of the four crops grown without manure or fertilizer, averaged $55.30 per acre.

2. At a total expense, for nitrate of soda, of $16.20 per acre, the income was increased to $70.95; the cash which was advanced for the fertilizer was therefore recovered, but no profits were made. When $14.68 was expended, per acre, for superphosphates, the total income was $63.09; the use of this material consequently resulted in a loss of $6.89 per acre.

3. Potash, used alone on plot 4, influenced the profits in a very marked manner; the increased returns from its use were sufficient to leave a balance of $21.59 after fertilizer charges had been met and due credit allowed for the product from the unmanured ground. *$21.59 is one hundred and eighty per cent. of $12, the cost of six hundred pounds of muriate of potash.*

4. Plots 7 and 8, upon which potash was used in combination with nitrogen and phosphoric acid, respectively, also gave profitable crops, the net gains being $23.16 in one case and $24.48 in the other. The combination of nitrogen, phosphoric acid and potash (plot 9) called for the largest investment but yielded the largest net profit, viz.,

$47.03, *or one hundred and ten per cent. of $42.80, the market value of twenty-six hundred pounds of a complete potato manure.*

5. During a period of four years, Mr. Arnold used 80 tons of stable manure per acre, upon plot 11, and converted it into crops worth $177.82. During the same period, without the aid of fertilizers, a portion of the same field in the same crops, gave returns worth $55.30. The value of the manure may therefore be estimated at $122.52, or a fraction more than *$1.50 per ton.*

The manure, of course, caused a marked improvement in the fertility of the field, but the value of this improvement cannot at present be definitely expressed. To study this point, a second rotation has been commenced upon the same plots, its first crop, Indian corn, having been gathered in 1886, and its second, sweet potatoes, in 1887; its third crop, viz., millet, is herewith reported:

## FIELD EXPERIMENTS WITH FERTILIZERS ON MILLET.

BY A. P. ARNOLD, VINELAND, CUMBERLAND COUNTY, N. J.

| Number of Plot. | Fertilizers. Kind. | Weight per Acre. | Cost per Acre | Pounds of Millet per Acre. | Value of Millet per Acre. | Net Gain or Loss. |
|---|---|---|---|---|---|---|
| 1 | Nothing.................. | .................. | ............ | 890 | $4.45 | ........... |
| 2 | Nitrate of Soda......... | 150 lbs ........ | $4.05 | 1,750 | 8.75 | +$0.73 |
| 3 | Superphosphate ......... | 350 lbs ......... | 3.67 | 880 | 4.40 | —3.24 |
| 4 | Muriate of Potash...... | 150 lbs ......... | 3.00 | 720 | 3.60 | —3.37 |
| 5 | Nitrate of Soda ....... <br> Superphosphate ......... | 150 <br> 350 lbs....... | 7 72 | 2,210 | 11.05 | —0.64 |
| 6 | Nothing .................. | .................. | ........... | 700 | 3.50 | ........... |
| 7 | Nitrate of Soda......... <br> Muriate of Potash...... | 150 <br> 150 lbs....... | 7.00 | 2,150 | 10.75 | —0.22 |
| 8 | Superphosphate ........ <br> Muriate of Potash...... | 350 <br> 150 lbs....... | 6.67 | 1,380 | 6.90 | —3.74 |
| 9 | Nitrate of Soda......... <br> Superphosphate ......... <br> Muriate of Potash...... | 150 <br> 350 lbs....... <br> 150 | 10.72 | 2,920 | 14.60 | —0.09 |
| 10 | Plaster ..................... | 400 lbs ......... | 1.50 | 640 | 3.20 | —2.27 |
| 11 | Fine Barn-yard Manure ...................... | 20 two-horse loads......... | 30.00 | 5,570 | 27.85 | —6.12 |

It has been stated above that these plots were selected in 1882, and that since this time the original plan has been followed without changes of any kind. Plots 1 and 6 have therefore received no plant-food, from manure or from fertilizers, for seven years; plot 11, on the other hand, has been dressed with 140 tons of yard manure per acre, and plot 9 has had per acre over two tons of a high-grade potato manure. The total amounts of plant-food used upon the other experiments during the same period may be learned by multiplying by seven the weights of fertilizer per acre published in the above table for each of said plots.

The fertilizers were applied about the middle of April, and at the same time the plots were seeded with millet and clover at the rate of one bushel each, upon six acres. Mr. Arnold reports that upon plots 1, 3, 4, 6, 8 and 10 the product was largely crab grass, and that the clover was a good catch only upon plots 8 and 11. In computing values, however, the product of each plot has been regarded as of the same quality; and the market value of millet in that section, viz., $10 per ton, has been used. The yields from plots 1 and 6 agree fairly well. A comparison of the average yield of those plots with yields from plots 3, 4 and 10 indicates that phosphoric acid, potash and plaster have practically no effect when used alone; a noticeable increase is observed, however, in plot 8 from the combination of superphosphate with muriate of potash. A very favorable influence on both catch and yield is exerted by nitrogen wherever used. Used alone, it increased the yield over that of the unmanured plots by 120 per cent., while only securing a profit of seventy-three cents; a financial loss followed the use of fertilizers in every other case. The financial values have been computed to serve as an aid in comparison of yields, rather than as an indication of profits or losses. Mr. Arnold's letter concerning the value of millet is here republished from the Fifth Annual Report of this Station.

He writes in substance as follows: "In making this report I do not wish it to be understood that a crop of millet was sought as a direct source of profit. Our problem here is to secure a clover sod upon which to grow a corn crop. If clover seed is sown alone, weeds take possession of the ground at first, and make the small amount of clover which is secured by late cutting of comparatively little value.

"By sowing millet and clover together I secure fodder which my stock consume as readily as they do baled hay worth here $20 per

ton. My clover, too, is not inferior to that secured by others, who seed down without millet and receive little or no benefit from the first cut, because of weeds."

| Number of Plot. | FERTILIZERS. | VALUE OF CROP | | | | | |
|---|---|---|---|---|---|---|---|
| | Kind. | 1882. Corn. | 1886. Corn. | 1883. Sweet Potatoes. | 1887. Sweet Potatoes. | 1884. Clover and Millet. | 1888. Millet. |
| 1 | Nothing .................. | $16.14 | $15.14 | $25.85 | $18.98 | $4.55 | $4.45 |
| 2 | Nitrate of Soda ........ | 21.28 | 18.67 | 25.61 | 17.18 | 10.05 | 8.75 |
| 3 | Superphosphate ........ | 15.96 | 20.50 | 29.93 | 11.79 | 5.30 | 4 40 |
| 4 | Muriate of Potash..... | 14.84 | 20.88 | 56.41 | 87.45 | 5.10 | 3.60 |
| 5 | { Nitrate of Soda<br>Superphosphate } ..... | 20.86 | 28.12 | 30.60 | 13.24 | 11.05 | 11.05 |
| 6 | Nothing ... .............. | 13.37 | 17.52 | 29.07 | 18.68 | 4.85 | 3.50 |
| 7 | { Nitrate of Soda.....<br>Muriate of Potash } | 23.17 | 25.18 | 52.65 | 72.16 | 12.15 | 10.75 |
| 8 | { Superphosphate ....<br>Muriate of Potash } | 15.79 | 25.09 | 65.77 | 81.60 | 6.00 | 6.90 |
| 9 | { Nitrate of Soda.....<br>Superphosphate....<br>Muriate of Potash } | 22.05 | 33.29 | 75.76 | 103.10 | 16.40 | 14.60 |
| 10 | Plaster.. .................. | 14.49 | 12.69 | 20.08 | 16.89 | 5.35 | 3.20 |
| 11 | { Fine Barn-yard<br>Manure. } ..... | 23 45 | 40.06 | 85.45 | 201.38 | 17.90 | 27.85 |

In the above table the corn crop grown in 1886, the sweet potatoes grown in 1887 and the millet grown in 1888 are compared with similar crops grown upon the same plots in 1882, 1883 and 1884, in order to determine roughly the loss or gain of fertility due to the persistent use of barn-yard manure and commercial fertilizers. Conclusions drawn from a comparison of the sweet potato crops, and published in the report of this Station for 1887, showed that, wherever potash had been used, the improvements in the value of the crop varied from 8 per cent. to 107 per cent., and that an improvement of 35 per cent. in the crop-producing power of the land had

therefore been gained without sacrifice of any kind. In all cases where potash was excluded, the decrease in the value of the second potato crop was serious, ranging from 36 to 63 per cent. The value of barn-yard manure in improving the crop-producing power of the land was estimated at $2.74 per ton.

A comparison of the crops of millet upon these plots shows an improvement of the soil in only two cases, plot 8 yielding 15 per cent. and plot 11, 56 per cent. more in 1888 than in 1884. On all the other plots the decrease in the yield ranges from 2 to 40 per cent. These results seemed to indicate that the sweet potato crop, immediately preceding, consumed all the crop-producing power that the soil had acquired up to that time, leaving the land in about the same condition of fertility as it was four years previous. Upon the eleventh plot, however, the accumulation of reserve plant-food from the annual addition of 20 tons of barn-yard manure seemed to have been sufficiently great to double the yield of sweet potatoes and afterwards increase the yield of millet 56 per cent. In comparing the two crops of millet, its value has been estimated on the basis of $10 per ton in both cases.

The complete record of Mr. Arnold's work up to date is here published in tabular form :

| FERTILIZERS. | | | YIELD PER ACRE. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1882. Corn. | | 1883. Sweet Potatoes. | | 1884. Clover and Millet. | 1885. Clover Hay. | | | 1886. Corn. | | 1887. Sweet Potatoes. | | 1888. Millet. |
| Number of Plot. | Kind. | Weight per Acre Used Annually in 1882, 1883, 1884, 1885, 1886 and 1887. | Bushels of Shelled Corn. | Pounds of Stalks. | No of Bushels Good. | No. of Bushels Poor. | Pounds. | Pounds. First Cut. | Pounds. Second Cut. | Total Weight. | Bushels of Shelled Corn. | Pounds of Stalks. | No. of Bushels Good. | No. of Bushels Poor. | Pounds. |
| 1 | Nothing ........................ | ..................... | 15.8 | 1,450 | 25.0 | 33 4 | 910 | 440 | 210 | 650 | 12.1 | 2,770 | 11.8 | 31.8 | 890 |
| 2 | Nitrate of Soda.................. | 150 lbs. | 22.7 | 1,540 | 25.8 | 30.2 | 2,010 | 450 | 210 | 660 | 19.4 | 2,840 | 13.0 | 22.6 | 1,750 |
| 3 | Superphosphate .................. | 350 lbs. | 15.0 | 1,560 | 29.4 | 37.4 | 1,060 | 680 | 420 | 1,100 | 14.5 | 3,990 | 3.0 | 31.3 | 880 |
| 4 | Muriate of Potash ....... ....... | 150 lbs. | 13.7 | 1,500 | 72.8 | 21.8 | 1,020 | 810 | 430 | 1,240 | 14.2 | 4,140 | 96.0 | 35.5 | 720 |
| 5 | { Nitrate of Soda ..................<br>Superphosphate . ........... .... | 150 } lbs.<br>350 } | 20.7 | 1,820 | 32.0 | 32.8 | 2,210 | 1,070 | 440 | 1,510 | 29.9 | 4,190 | 7.7 | 23.6 | 2,210 |
| 6 | Nothing ....................... .... | ..................... | 11.7 | 1,480 | 30.6 | 30.6 | 970 | 460 | 120 | 580 | 15.2 | 3,050 | 10.6 | 34.0 | 700 |
| 7 | { Nitrate of Soda....... ..........<br>Muriate of Potash................ | 150 } lbs.<br>150 } | 25.1 | 1,600 | 65.0 | 28.6 | 2,430 | 760 | 330 | 1,090 | 25.0 | 3,980 | 79.7 | 28.0 | 2,150 |
| 8 | { Superphosphate . ................<br>Muriate of Potash............... | 350 } lbs.<br>150 } | 14.4 | 1,630 | 80.6 | 37.2 | 1,200 | 1,530 | 620 | 2,150 | 13.3 | 5,460 | 90.0 | 32.0 | 1,380 |
| 9 | { Nitrate of Soda.......... .........<br>Superphosphate ...................<br>Muriate of Potash................. | 150 }<br>350 } lbs.<br>150 } | 23.1 | 1,680 | 92.8 | 43 2 | 3,280 | 1,680 | 740 | 2,420 | 32.2 | 5,370 | 118.0 | 29.0 | 2,920 |
| 10 | Plaster ........................... | 400 lbs. | 13.8 | 1,380 | 16.4 | 34.4 | 1,070 | 390 | 390 | 780 | 8.3 | 2,560 | 9.3 | 31.5 | 640 |
| 11 | Fine Barn-yard Manure......... | 20 2-horse loads. | 24.5 | 1,800 | 108.0 | 35.4 | 3,580 | 3,160 | 2,360 | 5,520 | 46.7 | 5,440 | 240.4 | 30.2 | 5,570 |

## FIELD EXPERIMENTS WITH FERTILIZERS ON PEACH TREES,

BY STEPHEN C. DAYTON, BASKINGRIDGE, SOMERSET COUNTY, N. J.

| Number of Plot. | Fertilizers. Kind. | Fertilizers. Amount per Plot in Pounds. | Number of Bearing Trees per Plot. | Baskets of Peaches per Plot | Average No. of Baskets per Tree in each Plot. | Baskets of Peaches per Acre of 130 Trees. | Value per Acre of Crop. |
|---|---|---|---|---|---|---|---|
| 1 | Nothing | ........ | 9 | 11.00 | 1.22 | 158.6 | $79.30 |
| 2 | Nitrate of Soda | 15 | 13 | 15.00 | 1.15 | 150.0 | 75.00 |
| 3 | Superphosphate | 35 | 12 | 20.75 | 1.73 | 224.9 | 112.45 |
| 4 | Muriate of Potash | 15 | 10 | 17.75 | 1.77 | 230.1 | 115.05 |
| 5 | Nitrate of Soda<br>Superphosphate | 15<br>35 } 50 | 12 | 31.75 | 2.65 | 344.5 | 172.25 |
| 6 | Nothing | ........ | 13 | 25.50 | 1.91 | 255.0 | 127.50 |
| 7 | Nitrate of Soda<br>Muriate of Potash | 15<br>15 } 30 | 13 | 29.50 | 2.27 | 295.0 | 147.50 |
| 8 | Superphosphate<br>Muriate of Potash | 35<br>15 } 50 | 13 | 32.25 | 2.48 | 322.5 | 161.25 |
| 9 | Nitrate of Soda<br>Superphosphate<br>Muriate of Potash | 15<br>35 } 65<br>15 | 10 | 32.25 | 3.22 | 418.6 | 209.30 |
| 10 | Plaster | 40 | 12 | 26.25 | 2.19 | 285.7 | 142.85 |
| 11 | Fine Barn-yard Manure | 2 2 horse loads. | 11 | 40.00 | 3.63 | 471.9 | 235.95 |
| 12 | Barn-yard Manure<br>Lime | 1 load.<br>5 bushels. | 13 | 26.75 | 2.06 | 267.8 | 133.90 |

This experiment was begun in 1884. Details as to the planting of the trees, the care of the orchard, and the application of fertilizers, have been published in previous reports of this Station. Since the beginning of the experiment, plots 1 and 6 have received no plant-food of any kind; of the remaining plots, no two were fertilized alike, but in other respects the treatment was identical. The above table will show the kind and quantity of materials used in each case; for

nstance, in 1884 plot 3 was dressed with superphosphate at the rate of hree hundred and fifty pounds per acre, and corn was planted between he trees. In 1885 the same plot was dressed again with the same naterial at the same rate, and buckwheat was sown. In 1886, 1887 and 1888 three hundred and fifty pounds of superphosphate were again applied each year for the use of the trees alone, no crops having been planted. Plot 3, therefore, had received superphosphate at the rate of seventeen hundred and fifty pounds per acre when the present crop was harvested. In the same manner plot 11 had received one hundred tons of barn-yard manure per acre.

The trees on all of the plots are uniform in size; the only effect produced by the fertilizers, so far as the eye could discern, has been n the darker green of the foliage on the trees of the superphosphate plot.

The second crop of peaches is reported this year; the season was very unfavorable for ripening the fruit and harvesting the crop. The fertilizers were applied again as usual in the spring of 1888. In calculating financial gains or losses for this year, the average of plots 1 and 6 is taken as indicating the value of unmanured land; to this s added the cost of fertilizers, and the sum is deducted from the value of the crops on each of the fertilized plots.

### EFFECT OF FERTILIZERS.

Assuming 50 cents to be the average net price per basket, plot 3 shows a net profit of only 85 cents, as against a net profit of $20.55 for the same plot in 1887. The very favorable effect of phosphoric acid alone upon all previous crops in this experiment, and its marked influence on fruit development when used in combinations this year, render it advisable to delay drawing conclusions on this point until the results of future years are secured, especially since no unfavorable conditions were reported as affecting this plot.

Nitrogen, when used alone, has been, as in the past, apparently injurious; in its combination with phosphoric acid and potash, however, a favorable influence is indicated.

Potash, when used alone, afforded a profit of $2.85; when used in combination with superphosphate, the profit was increased to $51.18.

The favorable effect of plaster noticed on previous crops is maintained to even a greater degree this year, securing a net profit of $37.95.

The effect of large quantities of barn-yard manure is beginning to be felt; its use on plot 11 secured a profit of $41.27 this year, against a loss of $22.85 for 1887.

### MANAGEMENT OF THE ORCHARD.

Mr. Dayton's letter concerning the care of the orchard and management of the trees for the past season is as follows:

"The long-continued rainy weather in September damaged the peaches very much, and, with the best care I could give them, some were lost, some rotted on the trees before they were ripe, and some dropped off prematurely, which makes the experiment somewhat unsatisfactory this year.

"The plots were plowed in the spring and the fertilizers were carefully sown and harrowed in as usual. They were not plowed again, as the limbs hung low with the weight of the fruit and I thought it unadvisable. The trees were carefully hoed around and the grubs looked after.

"The number of bearing trees in each plot is the same as last year, except in plot 11, which lost one tree during the winter; in plot 9 also, there are two trees of a different and tender variety, whose fruit almost entirely rotted on the trees; I have left these out in making up the table.

"The unhealthy trees on plots 1, 4 and 12 are not dead, but seem to be doing better. The trees generally are thrifty and healthy."

The table on the opposite page is offered as a financial statement of the condition of the experiment up to the present date.

It has already been stated that this orchard was set out on these experiment plots in 1884; that corn was planted the first year; that buckwheat was sown the second; that during the third, fourth and fifth years the ground was given up to the trees. It has also been stated that the fertilizers were applied each year; that the orchard came into bearing in 1887; and that with the exception of plot 3, in 1888, large profits were secured from the use of phosphoric acid, whether used alone or in combination with other kinds of plant-food; and that a previous experiment on another part of this farm had shown a uniformly favorable effect from the use of this element on field crops.

| Number of Plot. | FERTILIZERS. Kind. | Weight per Acre per Year, 1884, 1885, 1886, 1887. | Cost per Acre per Year. | VALUE OF CROP. Corn. 1884. | Buckwheat 1885. | Peaches. 1887. | Peaches. 1888. | Value of four Crops. | Cost of Fertilizers for five Years. | Profit or Loss for five Years. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Nothing | ...... | ...... | $24.44 | $5.61 | $53.30 | $79.30 | $162.65 | ...... | ...... |
| 2 | Nitrate of Soda | 150 lbs. | $4.05 | 27.08 | 6.66 | 40.80 | 75.00 | 149.54 | $20.25 | —$62 51 |
| 3 | Superphosphate | 350 lbs. | 3.67 | 35.37 | 20.12 | 81.25 | 112.45 | 249.19 | 18.35 | +39.04 |
| 4 | Muriate of Potash | 150 lbs. | 3.00 | 26.90 | 6.83 | 61.75 | 115.05 | 210.53 | 15.00 | +3.73 |
| 5 | Nitrate of Soda<br>Superphosphate | 150<br>350 } 500 lbs. | 7.72 | 37.14 | 21.29 | 70.35 | 172.25 | 301.03 | 38.60 | +70.63 |
| 6 | Nothing | ...... | ...... | 26.65 | 6.81 | 60.00 | 127.50 | 220.96 | ...... | ...... |
| 7 | Nitrate of Soda<br>Muriate of Potash | 150<br>150 } 300 lbs. | 7.05 | 26.37 | 5.47 | 56 90 | 147.50 | 236.24 | 35.25 | +9.09 |
| 8 | Superphosphate<br>Muriate of Potash | 350<br>150 } 500 lbs. | 6.67 | 37.65 | 22.94 | 86.80 | 161.25 | 308.64 | 33.35 | +83.49 |
| 9 | Nitrate of Soda<br>Superphosphate<br>Muriate of Potash | 150<br>350<br>150 } 650 lbs. | 10.72 | 39.55 | 22.85 | 76.10 | 209.30 | 347.80 | 53.60 | +102.40 |
| 10 | Plaster | 400 lbs. | 1.50 | 31.69 | 8.34 | 65.65 | 142.85 | 248.53 | 7.50 | +49.23 |
| 11 | Fine Barn-yard Manure | 20 2-horse loads | 30.00 | 46.16 | 19.19 | 73.80 | 235.95 | 375.10 | 150.00 | +33.30 |
| 12 | Barn-yard Manure<br>Lime | 10 loads<br>50 bushels | ...... | 38.58 | 16.69 | 31.20 | 133.90 | 220.37 | 103.00 | —74.43 |

This tabulation shows the values of crops already harvested, based upon calculations per acre, at prices ruling for those years. The average value per acre of crops grown on the unmanured plots is $191.80, an increase over the total value in 1887 of $103.40.

A summary of the results of 1887, as published in the report of this Station for that year, is as follows: A profit of over 200 per cent. was secured from superphosphate alone, but wherever used in combination with either nitrogen or potash, and in complete manure, the profit was decreased by more than the cost of fertilizers used. This fact was also shown in the case of barn-yard manure, where an application of 80 tons resulted in a loss of $69.25. Plaster showed a profit of $11.28. Up to that time, therefore, plaster and superphosphate were the only profitable fertilizers for peach trees.

The results of this year show that, in addition to superphosphate and plaster, *potash and barn-yard manure* can be added to the list of profitable fertilizers.

The use of superphosphate alone, while securing a profit, has materially reduced the net percentage profit. Potash has changed the financial balance from —$4.93, in 1887, to +$3.73 for the present year. Barn-yard manure has been effective in changing a loss of $69.25, in 1887, into a profit of $33.30, in 1888.

The following table shows the percentage increase in the total value of the crops caused by the crop of 1888, and the percentage profit or loss secured from four crops and five crops respectively:

| Number of Plot. | FERTILIZERS. Kind. | Weight per Acre per Year, 1884, 1885, 1886, 1887. | Cost per Acre per year. | VALUE OF CROP. Peaches. 1887. | Peaches. 1888. | Value of three Crops. | Value of four Crops. | Cost of Fertilizers for four Years. | Cost of Fertilizers for five Years. | Profit or Loss for four Years. | Profit or Loss for five Years. | Percentage increase in value by Crop of 1888. | Percentage Profit or Loss for four Years. | Percentage Profit or Loss for five Years. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Nothing | ........ | ........ | $53.30 | $79.30 | $83.35 | $162.65 | ........ | ........ | ........ | ........ | 95 | ........ | ........ |
| 2 | Nitrate of Soda | 150 lbs. | $1.05 | 40.80 | 75.00 | 74.54 | 149.54 | $16.20 | $20.25 | —$30.06 | —$62.51 | 101 | —185 | —300 |
| 3 | Superphosphate | 350 lbs. | 3.67 | 81.25 | 112.45 | 136.74 | 219.19 | 14.68 | 18.35 | +33.66 | +39.04 | 82 | +229 | +212 |
| 4 | Muriate of Potash | 150 lbs. | 3.00 | 61.75 | 115.05 | 95.48 | 210.53 | 12.00 | 15.00 | —4.92 | +3.73 | 120 | —41.0 | +25 |
| 5 | { Nitrate of Soda<br>{ Superphosphate | 150 } 500 lbs.<br>350 } | 7.72 | 70.35 | 172.25 | 128.78 | 301.03 | 30.88 | 38.60 | +9.50 | +70.63 | 133 | +30.7 | +183 |
| 6 | Nothing | ........ | ........ | 60.00 | 127.50 | 93.46 | 220.96 | ........ | ........ | ........ | ........ | 136 | ........ | ........ |
| 7 | { Nitrate of Soda<br>{ Muriate of Potash | 150 } 300 lbs.<br>150 } | 7.05 | 56.90 | 147.50 | 88.74 | 236.24 | 28.20 | 35.25 | —17.86 | +9.09 | 166 | —63.3 | +25 |
| 8 | { Superphosphate<br>{ Muriate of Potash | 350 } 500 lbs.<br>150 } | 6.67 | 86.80 | 161.25 | 147.39 | 308.64 | 26.68 | 33.35 | +32.21 | +83.49 | 109 | +120 | +250 |
| 9 | { Nitrate of Soda<br>{ Superphosphate<br>{ Muriate of Potash | 150 }<br>350 } 650 lbs.<br>150 } | 10.72 | 76.10 | 209.30 | 138.50 | 347.80 | 42.88 | 53.60 | +7.22 | +102.40 | 143 | +16.8 | +191 |
| 10 | Plaster | 400 lbs. | 1.50 | 65.65 | 142.85 | 105.68 | 248.53 | 6.00 | 7.50 | +11.28 | +49.2[illegible] | 135 | +188 | +656 |
| 11 | Fine Barn-yard Manure | { 20 2-horse loads ... } | 30.00 | 73.80 | 235.95 | 139.15 | 375.10 | 120.00 | 150.00 | —69.25 | +33.30 | 168 | —57.7 | +22 |
| 12 | { Barn-yard Manure<br>{ Lime | 10 loads ... }<br>50 bushels .. } | ........ | 31.20 | 133.90 | 86.47 | 220.37 | 82.40 | 103,00 | —84.33 | —74.43 | 154 | —102 | —72 |

The increase in the total value of the crops upon the unmanured plots by the crop of 1888, is 116 per cent. This percentage increase has been largely exceeded on all fertilized plots, except plots 2, 3 and 8. The greatest increase was produced by barn-yard manure on plot 11. The yield of plot 2 is in accord with the record of previous years; on plot 3, however, the result is contrary to all previous records for phosphoric acid, and its explanation must await the results of future crops. The cumulative effect of fertilizers is shown very strikingly in the columns indicating profit and loss for four years and for five years respectively; with the single exception of nitrogen, the percentage profits to date range from 62 to over 650 per cent. Plots 4, 7 and 11 show a profit for the first time this year, while plots 3, 5, 8 and 10 had $12.74, $3.40, $10.84 and $3.76, respectively, to their credit in 1886 previous to the harvesting of any peach crop. The full effect of fertilizers and the proper balancing of profit and loss accounts cannot be indicated, however, until the orchard has ceased profitable bearing.

For the benefit of those interested, details as to the results of all experiments carried out on different parts of the farm since 1881 are here tabulated:

## EXPERIMENTS BY MR. S. C. DAYTON, BASKING RIDGE, SOMERSET COUNTY.

| Number of Plot. | FERTILIZERS. Kind. | Weight per Acre. | Cost per Acre. | YIELD PER ACRE. Corn. 1881. Bushels of Corn. | Corn. 1881. Pounds of Stalks. | Oats. 1882. Bushels of Oats. | Oats. 1882. Pounds of Straw. | Clover. 1883. Pounds per Acre. First Cut. | Clover. 1883. Pounds per Acre. Second Cut. | Clover. 1883. Total Weight per Acre. | Corn. 1884. Bushels of Corn. | Corn. 1884. Pounds of Stalks. | Buckwheat. 1885. Bushels of Buckwheat. | Buckwheat. 1885. Pounds of Straw. | Peach Trees. 1886. Number of Peaches | Peach Trees. 1887. Number of Baskets of Peaches. | Peach Trees. 1888. Number of Baskets of Peaches. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Nothing | ........ | ........ | 5.0 | 490 | 20.0 | 690 | 260 | 730 | 990 | 41.3 | 1,670 | 7.8 | 620 | 40 | 106.6 | 158.6 |
| 2 | Nitrate of Soda | 150 lbs. | $4.05 | 5.3 | 570 | 22.3 | 840 | 260 | 800 | 1,060 | 45.4 | 1,900 | 9.3 | 705 | 100 | 81.55 | 149.5 |
| 3 | Superphosphate | 350 lbs. | 3.67 | 10.1 | 640 | 45.6 | 1,750 | 3,050 | 2,650 | 5,700 | 60.7 | 2,300 | 26.8 | 2,690 | 250 | 162.50 | 224.9 |
| 4 | Muriate of Potash | 150 lbs. | 3.00 | 6.3 | 570 | 18.6 | 690 | 280 | 860 | 1,140 | 44.6 | 1,950 | 9.5 | 755 | 30 | 123.50 | 230.1 |
| 5 | Nitrate of Soda<br>Superphosphate | 150<br>350 lbs. | 7.72 | 12.8 | 960 | 57.6 | 2,180 | 3,200 | 2,700 | 5,900 | 63.4 | 2,460 | 28.6 | 2,750 | 460 | 140.7 | 344.5 |
| 6 | Nothing | ........ | ........ | 4.9 | 580 | 15.0 | 460 | 260 | 720 | 980 | 44.2 | 1,930 | 9.6 | 700 | 120 | 119.99 | 252.2 |
| 7 | Nitrate of Soda<br>Muriate of Potash | 150<br>150 lbs. | 7.00 | 6.3 | 680 | 20.3 | 670 | 380 | 950 | 1,330 | 43.1 | 1,990 | 7.7 | 565 | 30 | 113.75 | 295.0 |
| 8 | Superphosphate<br>Muriate of Potash | 350<br>150 lbs. | 6.67 | 16.3 | 750 | 44.0 | 1,590 | 4,850 | 3,650 | 8,500 | 63.2 | 2,630 | 30.6 | 3,050 | 140 | 173.68 | 322.4 |
| 9 | Nitrate of Soda<br>Superphosphate<br>Muriate of Potash | 150<br>350<br>150 lbs. | 10.72 | 19.4 | 880 | 60.0 | 2,450 | 4,950 | 3,900 | 8,850 | 67.5 | 2,620 | 30.0 | 3,230 | 160 | 152.23 | 418.6 |
| 10 | Plaster | 400 lbs. | 1.50 | 5.8 | 390 | 18.3 | 750 | 320 | 900 | 1,220 | 54.4 | 2,060 | 11.4 | 1,000 | 120 | 131.30 | 285.7 |
| 11 | Fine Barn-yard Manure | 20 2-horse loads. | 30.00 | 13.4 | 780 | 58.6 | 2,200 | 4,900 | 4,300 | 9,200 | 76.3 | 3,380 | 24.6 | 2,950 | 110 | 147.55 | 433.9 |

## FIELD TRIALS WITH CANADIAN ASHES, DOMESTIC ASHES, DISSOLVED SOUTH CAROLINA ROCK AND ORCHILLA GUANO.

BY A. P. ARNOLD, VINELAND.

The following experiment was planned by Mr. Arnold, and will be carried through the rotation. The amounts and kinds of fertilizers indicated in the table were applied in the spring of 1885 and of 1888. The sweet potatoes were dressed with 15 one-horse loads of barn manure.

The average yields of unmanured land in the different years were secured from the records of blank plots in another experiment conducted by Mr. Arnold under the direction of the Station.

The following entries are made as a record simply, the consideration of the plan and its results being deferred until the trial is completed:

## FIELD TRIALS WITH CANADIAN ASHES, DOMESTIC ASHES, DISSOLVED SOUTH CAROLINA ROCK AND ORCHILLA GUANO.

BY A. P. ARNOLD, VINELAND.

| Number of Plot. | FERTILIZERS. | | | YIELD PER ACRE. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Kind. | Amount per Acre—1885-1888. | Total Cost per Acre. | 1885. Clover. | | | 1886. Corn. | | | 1887. Sweet Potatoes. | | | | 1888. Millet. |
| | | | | Pounds. First Cut. | Pounds. Second Cut. | Total Weight. | Bushels of Shelled Corn, Good. | Bushels of Shelled Corn, Poor. | [illegible] of Stalks. | Po[illegible]s—Large. | Pounds—Small. | Total Weight, Pounds. | Bushels. | Pounds. |
| A | Canada Ashes | 100 bus. | $70 00 | 1,380 | 1,360 | 2,740 | 36.8 | 0.9 | 6,020 | 10,680 | 1,500 | 12,180 | 223.7 | 2,300 |
| B | Home Ashes | 100 bus. | ........ | 1,240 | 940 | 2,180 | 37.0 | 0.8 | 5,560 | 8,550 | 1,380 | 9,930 | 183.9 | 2,290 |
| C | Dissolved S C. Rock | 1,000 lbs. | 17 08 | 2,120 | 740 | 2,860 | 36.5 | 1.0 | 4,680 | 9,870 | 1,880 | 11,750 | 217.6 | 2,150 |
| D | Orchilla Guano | 1,000 lbs. | 23 75 | 2,110 | 590 | 2,700 | 35.3 | 1.2 | 4,960 | 8,280 | 1,540 | 9,820 | 181.8 | 1,730 |
| | No Manure | .......... | ........ | 450 | 165 | 615 | 13.7 | ........ | 2,910 | 608 | 1,775 | 2,383 | 49.1 | 795 |

## FIELD EXPERIMENTS WITH FERTILIZERS ON CORN, 1886, OATS, 1887, AND WHEAT. 1888.

BY THEODORE WEST, COLLEGE FARM, NEW BRUNSWICK, N. J.

| Number of Plot. | FERTILIZERS. | | | YIELD PER ACRE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | CORN. | | OATS. | | WHEAT. | |
| | Kind. | Weight per Acre. | Cost per Acre. | Bushels of Shelled Corn. | Pounds of Stalks. | Bushels of Oats. | Pounds of Straw. | Bushels of Wheat. | Pounds of Straw. |
| 1 | Nitrate of Soda.................. | 160 lbs. | $4.32 | 61.3 | 5,120 | 45.0 | 1,720 | 28.5 | 3,328 |
| | No Fertilizer..................... | ............ | ........ | 50.0 | 4,800 | 46.5 | 1,530 | 30.7 | 3,258 |
| 2 | Superphosphate ................... | 300 lbs. | 3.20 | 46.0 | 5,200 | 42.0 | 1,460 | 29.9 | 3,305 |
| | No Fertilizer..................... | ............ | ........ | 48.8 | 4,600 | 45.6 | 1,480 | 28.3 | 2,871 |
| 3 | Muriate of Potash............... | 150 lbs. | 3.00 | 50.5 | 5,600 | 48.2 | 1,400 | 26.0 | 3,012 |
| | No Fertilizer..................... | ............ | ........ | 47.0 | 4,660 | 44.4 | 1,520 | 33.6 | 3,493 |
| 4 | { Nitrate of Soda, 160 / Superphosphate, 300 } ......... | 460 lbs. | 7.52 | 53.3 | 5,200 | 44.7 | 1,370 | 32.8 | 3,657 |
| | No Fertilizer..................... | ............ | ........ | 46.0 | 5,000 | 49.1 | 1,590 | 27.3 | 2,696 |
| 5 | { Nitrate of Soda, 160 / Muriate of Potash, 150 } ..... | 310 lbs. | 7.32 | 55.3 | 6,000 | 46.5 | 1,554 | 29.9 | 3,832 |
| | No Fertilizer..................... | ............ | ........ | 41.5 | 5,200 | 41.3 | 1,540 | 30.9 | 3,118 |
| 6 | { Superphosphate, 300 / Muriate of Potash, 150 } ..... | 450 lbs. | 6.20 | 41.3 | 5,600 | 43.4 | 1,010 | 28.5 | 3,328 |
| | No Fertilizer..................... | ............ | ........ | 43.8 | 4,700 | 51.0 | 1,270 | 27.8 | 2,549 |
| 7 | { Nitrate of Soda, 160 / Superphosphate, 300 / Muriate of Potash, 150 } ..... | 610 lbs. | 10.52 | 52.0 | 6,000 | 42.5 | 1,240 | 30.9 | 3,539 |
| | No Fertilizer..................... | ............ | ........ | 42.0 | 5,200 | 47.5 | 1,480 | 27.0 | 2,602 |
| 8 | Plaster ............................ | 400 lbs. | 1.50 | 39.3 | 5,300 | 41.3 | 1,280 | 29.7 | 2,789 |
| | No Fertilizer..................... | ............ | ........ | 38.5 | 5,400 | 45.3 | 1,550 | 25.4 | 2,344 |
| 9 | No Fertilizer..................... | ............ | ........ | 38.5 | 5,460 | 42.2 | 1,250 | 25.0 | 2,485 |
| | Fine Barn-yard Manure....... | 20 tons. | 30.00 | 68.3 | 6,400 | 48.4 | 1,650 | 27.0 | 3,774 |

This experiment, begun in 1886, was planned to show:

I. The variations in yields between unmanured plots;
II. The effects both of barn-yard manure and commercial fertilizers upon the growth of corn, oats, wheat and grass.

The above plots are located in the center of a field which was cropped in 1882 with fodder corn, grown with a heavy dressing of barn-yard manure. Since that time, without the addition of plant-food of any kind, it had yielded heavy crops of rye, clover and mixed hay.

This is the third crop reported in this rotation. Fertilizers were applied in the usual manner upon corn and wheat.

In the report on corn in 1886 and on oats in 1887, considerable variations were noted in the yields from the unmanured plots. These variations are no less marked this year.

With the exception of the corn on plot 11, the crops thus far produced have not been influenced by the use of large amounts of plant-food. This result is in accord with those secured in previous rotations on this farm, in which it was shown that no combination of commercial fertilizers was followed by financial profit.

The conditions were favorable for both harvesting and threshing, and noticeable losses were thereby avoided.

The plots have been seeded to timothy and clover without further addition of fertilizers. These entries are made as a record simply, the consideration of the results being deferred until the trial is completed.

## FIELD TRIALS UPON WHEAT,

MADE TO TEST AND COMPARE

*Phosphoric Acid derived from Bone Black, or Bone Ash, and South Carolina Rock.*

"At a late meeting of the Salem County Board of Agriculture the following preamble and resolution were adopted, viz.:

"WHEREAS, Dissolved South Carolina rock is a much cheaper source of phosphoric acid than dissolved bone; and

"WHEREAS, The value of the first to the crop subsequent to that to which it is applied is questioned;

"*Resolved*, That the Salem County Board of Agriculture request our Experiment Station to carry out such experiments as will decide the relative agricultural value of phosphoric acid from dissolved rock and from dissolved bone.

H. C. PERRY,
"ALLOWAY, May 11th, 1887. *Secretary.*"

In response to the above resolution, passed by the Salem County Board of Agriculture, the following experiments were planned and carried out on wheat, for the purpose of aiding in the solution of the question involved. This question, expressing exactly the intent of the resolution as indicated in a letter from the Secretary of the Board, received at a later date, is as follows: What is the relative agricultural value of phosphoric acid derived from South Carolina rock superphosphate and bone-black, or bone-ash, superphosphate?

### LOCATION OF EXPERIMENTS AND DESCRIPTION OF SOILS.

The experiments have been made upon four farms in Salem county and upon the College Farm. The farms in Salem county are all underlaid by marl-beds. That of Mr. Flitcraft lies near Woodstown, is level and dry, consists of a heavy clay loam and is in a good state of cultivation.

Mr. Gaunt's farm is situated near Pittsgrove. It is oakland soil, medium clay, dry, and well adapted to grain and hay.

H. C. Perry, of Alloway, has a rather light soil of yellow sandy clay, susceptible of great increase in fertility by cultivation and the use of fertilizers.

The soil upon the farm of Mr. Cooper, near Pedricktown, is a sandy loam, especially suitable for trucking and fruits.

The College Farm consists largely of decomposed shale; it has been manured heavily for several years and is in a high state of cultivation.

### DETAILS OF EXPERIMENTS.

The Station planned to have every experiment consist of three groups, each group including three plots, and each a duplicate of the other, in order that the results secured from a series of plots might be compared under the same conditions respecting area and kind and amount of plant-food applied. Every experiment, therefore, was

intended to include nine plots, treated as follows: Upon plots 1, 4 and 7, no phosphatic fertilizer; upon 2, 5 and 8, bone-black superphosphate; and upon 3, 6 and 9, South Carolina rock superphosphate.

One acre of land divided into nine parallel plots, with spaces of thirty-two inches between plots, furnished one-tenth of an acre area in each plot. In two cases nine plots were under experiment; in three cases only six could be secured; the size and shape of the plots, however, were the same throughout.

Except upon the farm of Mr. Flitcraft, who had manured his land, the ground under experiment, previous to the addition of the superphosphates, was uniformly fertilized with a mixture furnishing fifteen pounds of nitrogen and twenty pounds of potash per acre. The fertilizers were sown and the grain seeded early in October, 1887. In every case the chemist of the Station was present to witness this work.

Details as to the kind and quantity of superphosphate used and the weights of grain and straw harvested can be learned from the table on the following page. These results are valuable only in so far as they may assist in interpreting the main question, which is to be decided by the crop of 1889, and to this end the plots under experiment are now seeded to timothy and clover.

## CONSIDERATION OF RESULTS.

In three experiments a wide variation is noticed in the yield from the plots untreated with superphosphate.

Bone-black superphosphate was effective in producing an increased yield in each experiment when considered as a whole, though only effective in seven cases out of twelve when groups are considered separately.

In four experiments South Carolina rock superphosphate increased the yield of both grain and straw. It was effective, however, on only five plots out of the twelve upon which it was applied.

Bone black and South Carolina rock were both effective on only four plots out of the twelve. In one case the increase from bone-black superphosphate exceeded that from South Carolina rock superphosphate by 24 per cent., while in three cases the average increase in yield from the use of South Carolina rock exceeded that from bone black by 17.5 per cent.

| Number of Group | | 1 | | | 2 | | | 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of Plot | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | KIND AND QUANTITY OF SUPERPHOSPHATE USED PER ACRE. | Without Superphosphate. | 330 Pounds of Bone-Black Superphosphate.* | 440 Pounds of S. C. Rock Superphosphate.* | Without Superphosphate. | 330 Pounds of Bone-Black Superphosphate. | 440 Pounds of S. C. Rock Superphosphate. | Without Superphosphate. | 330 Pounds of Bone-Black Superphosphate. | 440 Pounds of S. C. Rock Superphosphate. |
| Reeves Flitcraft, Woodstown, Salem County | Pounds of Grain | 1,640 | 1,480 | 1,270 | 1,420 | 1,560 | 1,330 | ........ | ........ | ........ |
| | Bushels of Grain | 27.3 | 24.7 | 21.2 | 23.7 | 26.0 | 22.2 | ........ | ........ | ........ |
| | Pounds of Straw | 2,730 | 2,230 | 1,750 | 1,880 | 2,250 | 1,930 | ........ | ........ | ........ |
| Elmer Gaunt, Pittsgrove, Salem County | Pounds of Grain | 950 | 1,440 | 1,310 | 1,140 | 1,350 | 1,140 | ........ | ........ | ........ |
| | Bushels of Grain | 15.8 | 24.0 | 21.8 | 19 0 | 22.5 | 19.0 | ........ | ........ | ........ |
| | Pounds of Straw | 1,270 | 1,950 | 1,700 | 1,530 | 1,605 | 1,330 | ........ | ........ | ........ |
| H. C. Perry, Alloway, Salem County | Pounds of Grain | 433 | 425 | 385 | 375 | 465 | 565 | 450 | 673 | 735 |
| | Bushels of Grain | 7.2 | 7.1 | 6.4 | 6.3 | 7.8 | 9.4 | 7.5 | 11.2 | 12.3 |
| | Pounds of Straw | 538 | 725 | 775 | 675 | 855 | 985 | 1,030 | 1,328 | 1,435 |
| Joseph Cooper, Pedricktown, Salem County | Pounds of Grain | 919 | 880 | 1,030 | 980 | 980 | 1,107 | ........ | ........ | ........ |
| | Bushels of Grain | 15.3 | 14.7 | 17.2 | 16.3 | 16.3 | 18.5 | ........ | ........ | ........ |
| | Pounds of Straw | 1,295 | 1,334 | 1,483 | 1,600 | 1,644 | 1,683 | ........ | ........ | ........ |
| B. C. Sears, College Farm, Middlesex County | Pounds of Grain | 1,620 | 1,550 | 1,560 | 1,610 | 1,870 | 2,080 | 2,190 | 2,160 | 2,340 |
| | Bushels of Grain | 27.0 | 25.8 | 26.0 | 26.8 | 31.2 | 34.7 | 36.5 | 36.0 | 39.0 |
| | Pounds of Straw | 3,230 | 3,150 | 3,260 | 2,990 | 3,380 | 3,720 | 3,810 | 4,190 | 4,160 |

* The analyses of these Superphosphates are as follows: The Bone-Black Superphosphate contained 19.62 per cent. available, and 0.72 per cent. insoluble phosphoric acid; the South Carolina Rock Superphosphate contained 12.49 available, and 2.88 insoluble phosphoric acid.

# LUCERN, OR ALFALFA.

(*Medicago sativa.*)

In the spring of 1887 a circular was issued by this Station in which lucern, or alfalfa, and the claims made for it as a fodder plant, were described substantially as follows:

Alfalfa is a forage plant which closely resembles clover, not only in feeding value, but also in its habits of growth and effects upon following crops. It has been cultivated in Europe for nearly two thousand years, and is now well known both in North and South America. In California, in particular, its importance is fully appreciated by stockmen.

For New Jersey, it is claimed that in comparison with red clover, alfalfa has the following advantages:

1. It is fit for soiling purposes as early as the third week in May.
2. It may be cut three or four times each season.
3. The second and later growths, if harvested as soon as blossoms appear, make an excellent hay.
4. When well rooted it successfully resists both drought and frost.
5. Under favorable conditions it does not "run out" for many years.

It has been grown in the Eastern and Middle States ever since 1791, but in spite of its apparent advantages it has never been in general use. For this, numerous explanations are offered, among which the following may be noted:

1. The first growth is fit to cut before the weather is suitable for hay-making. If allowed to mature, the stems grow woody and are rejected by stock.
2. Trouble has been experienced in securing a good stand.

These advantages and alleged disadvantages warranted the Station in planning a series of experiments to test its value upon the different

soils of New Jersey. Ten experiments, therefore, were then begun, distributed among seven counties of the State. Of these the one upon the College Farm alone has proved successful. Its success is believed to be due almost entirely to the fact that it was the first one seeded, and was, from the start, aided by favorable weather and tillage. The details of this experiment are as follows:

### PLAN OF EXPERIMENT.

A plot 30 feet wide and 150 feet long was carefully prepared. It had been in corn the preceding year, and, as the subsoil is a rather compact clay, it was not believed to be specially fitted for alfalfa. Eighty pounds of a complete fertilizer, having an unusually high percentage of nitrogen and potash, were spread upon it broadcast. Approximately one-half of the plot was then seeded in drills at the rate of 15 pounds of seed per acre; the rows were 14 inches apart. The other half of the plot was seeded broadcast at the rate of 30 pounds of seed per acre.

### REPORT ON THE SECOND YEAR'S GROWTH OF ALFALFA UPON THE COLLEGE FARM.

Upon the 27th of April, 1888, fifty pounds of a complete fertilizer—analyzing 2.79 per cent. total nitrogen, 10.87 per cent. total phosphoric acid, 7.69 per cent. available phosphoric acid, and 4.22 per cent. potash—were broadcasted upon the two plots of alfalfa, which at this time showed a thick stand and was growing rapidly and vigorously. Clover had not yet made any start.

Upon May 10th the drilled plot was cultivated; the alfalfa then had a height of fifteen and a half inches. Upon May 19th its growth had become very heavy but it showed no blossoms. It has been demonstrated that the best results are secured from alfalfa when it is cut just after the blossoms have appeared. In order to wait for this stage in its growth, therefore, and also because the weather was almost continuously wet or cloudy, the crop was left untouched until June 4th, when the first cutting was secured; even at this date no blossoms were visible, although blossom buds were plainly developed. The maximum height of the alfalfa at this time was forty inches, the average length of the plants being about thirty-two inches. Both

plots were quite free from weeds, and no dodder was visible. Clean mowing was very difficult, owing to the alfalfa being very much down and twisted, this being the case especially with the drilled plot. *The yield was nine and three-tenths tons of green fodder per acre on the drilled plot and nine and nine-tenths tons per acre on the broadcasted plot.*

On June 15th the drilled plot was again cultivated. The alfalfa was then ten inches high. Blossoms began to appear June 30th, and on July 5th, when it was in full bloom, the second cutting was secured. Its height was then twenty inches upon the drilled, and eighteen inches upon the broadcasted plot, but upon the latter the growth was thicker and just as free from weeds. *The yield was four and four-tenths tons of green fodder per acre on each plot,* this growth having been made during an interval of thirty days.

The third cutting was secured on August 6th, at which time the alfalfa had an average height of only eight inches, and looked very badly. Its leaves had turned yellow; no dodder was visible; the broadcasted plot contained a great deal of plantain. *The yield of green fodder per acre was two and one-tenth tons on the drilled, and two and four-tenths tons on the broadcasted plot.*

On August 6th, immediately after the third cut was secured, the two plots received an application of 35 pounds of bone-black superphosphate and 15 pounds of muriate of potash. On August 28th there was a fine, vigorous growth of sixteen inches, which, on September 14th, had increased to twenty-two inches. Although very few blossoms were visible as yet, the alfalfa was cut for the fourth time, and *yielded three tons per acre on the drilled, and four and two-tenths tons per acre on the broadcasted plot.*

Following this cutting there was a rank growth, which would have yielded a good crop early in October, had it not been deemed best to omit further cutting this season, pasturing lightly instead. *The total yield of green fodder per acre during the season of 1888, therefore, was eighteen and eight-tenths tons from the drilled plot and twenty and nine-tenths tons from the broadcasted plot.*

At the beginning of winter the alfalfa showed a good stand, although bare spots could be seen in parts of the drilled plot, and plantain had taken possession of a small spot in the center of the broadcasted plot. It is believed that the delay in cutting the first crop this season materially injured the subsequent crops.

### CHEMICAL COMPOSITION OF THIS CROP.

Each cut of alfalfa was sampled immediately after the crop was secured. The analyses of these samples are as follows:

| Station Number. | | Tonnage per Acre. | POUNDS PER HUNDRED OF | | | | | | PERCENTAGE OF | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Water. | Fat. | Fiber. | Ash. | Proteine. | Carbohydrates. | Nitrogen. | Phosphoric Acid. | Potash. |
| 454 | 1st Cut, Drilled | 9.30 | 79.46 | 0.89 | 5.00 | 2.03 | 4.17 | 8.45 | 0.67 | 0.14 | 0.69 |
| 455 | " " Broadcast | 9.90 | 80.61 | 0.79 | 4.48 | 2.04 | 4.02 | 8.06 | 0.64 | 0.13 | 0.78 |
| 456 | 2d " Drilled | 4.35 | 64.37 | 1.33 | 6.54 | 2.81 | 5.43 | 19.52 | 0.87 | 0.19 | 0.91 |
| 457 | " " Broadcast | 4.41 | 61.69 | 1.24 | 9.08 | 3.15 | 6.42 | 18.42 | 1.03 | 0.20 | 0.89 |
| 458 | 3d " Drilled | 2.05 | 69.41 | 1.29 | 5.58 | 2.81 | 5.42 | 15.49 | 0.87 | 0.10 | 0.80 |
| 459 | " " Broadcast | 2.40 | 72.45 | 0.91 | 5.95 | 2.70 | 4.86 | 13.13 | 0.78 | 0.12 | 0.80 |
| 460 | 4th " Drilled | 3.00 | 77.44 | 1.16 | 4.75 | 2.38 | 4.90 | 9.37 | 0.79 | 0.14 | 0.74 |
| 461 | " " Broadcast | 4.15 | 78.33 | 1.26 | 4.68 | 2.26 | 4.26 | 9.21 | 0.68 | 0.15 | 0.70 |
| | **Total Tonnage per Acre and Average Composition of Crop on Drilled Plot** | **18.70** | **72.67** | **1.17** | **5.47** | **2.51** | **4.98** | **13.21** | **0.80** | **0.14** | **0.80** |
| | **Total Tonnage per Acre and Average Composition of Crop on Broadcast Plot** | **20.86** | **73.27** | **1.05** | **6.03** | **2.54** | **4.79** | **12.21** | **0.78** | **0.15** | **0.79** |

No marked differences are noticed in the composition of the alfalfa from the two plots. The total yield on the broadcast plot was 11.5 per cent. greater than on the drilled plot.

The following table shows the yields and average composition of the alfalfa from the drilled plot for 1887 and 1888, and from the broadcasted plot for 1888. These have been calculated to the hay basis for the purpose of comparing with clover, which is everywhere recognized to be one of the most valuable plants grown, in its various relations to agriculture.

The table shows that 39.49 tons of the green alfalfa on the drilled plot would dry to 9.98 tons of hay, and that 20.86 tons on the broadcast plot would dry to 6.04 tons. Since no cuts were made on the broadcast plot in 1887, there remains a balance to the credit of the drilled plot of 3.94 tons, which, exclusive of the cost of cultivating and hoeing, represents to this date the advantage of seeding in drills

| | Tonnage per Acre. | POUNDS PER HUNDRED OF | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Water. | Crude Fat. | Crude Fiber. | Ash. | Crude Proteine. | Carbohydrates | Nitrogen. | Phosphoric Acid. | Potash. |
| 1887. Drilled Plot................ | 20.79 | 80.34 | 0.83 | 4.51 | 2.07 | 3.82 | 8.44 | 0.61 | 0.11 | 0.69 |
| 1888. " " ................ | 18.70 | 72.67 | 1.17 | 5.47 | 2.51 | 4.98 | 13.21 | 0.80 | 0.14 | 0.80 |
| " Broadcasted Plot........ | 20.86 | 73.27 | 1.05 | 6.03 | 2.54 | 4.79 | 12.21 | 0.78 | 0.15 | 0.79 |
| **1887. Drilled Plot on the Hay basis..................** | **4.44** | **7.70** | **3.89** | **21.17** | **9.80** | **17.93** | **39.62** | **2.90** | **0.52** | **3.24** |
| **1888. Drilled Plot on the Hay basis................** | **5.54** | **7.70** | **3.95** | **18.47** | **8.48** | **16.82** | **44.61** | **2.70** | **0.47** | **2.70** |
| **1888. Broadcasted Plot on the Hay basis..........** | **6.04** | **7.70** | **3.63** | **20.82** | **8.77** | **16.54** | **42.16** | **2.69** | **0.52** | **2.73** |
| **Average Composition of Clover Hay..................** | ......... | **7.70** | **2.08** | **28.20** | **6.80** | **12.46** | **42.77** | **1.99** | **0.36** | **1.68** |

over broadcast seeding. The drilled plot was cultivated five times and hoed once during the first year's growth in 1887; in 1888 it was cultivated but three times. An exact record of the cost of this cultivating and hoeing has not been kept, but it is estimated to be not more expensive, with proper tools, than the cultivation of field corn.

ALFALFA CONSIDERED AS A FOOD IN COMPARISON WITH CLOVER AND TIMOTHY.

| DRILLED PLOT. | Tonnage on the Hay basis. | Fat. | Fiber. | Proteine. | Carbohydrates. | Feeding value of Crop per Acre. |
|---|---|---|---|---|---|---|
| | | lbs. | lbs. | lbs. | lbs. | |
| 1887. Total.......................................... | 4.44 | 345.1 | 1875.3 | 1588.4 | 3509.4 | ............... |
| **1887. Digestible.............................** | ......... | **155.3** | **768.9** | **1286.6** | **2526.8** | **92.15** |
| 1888. Total.......................................... | 5.44 | 437.6 | 2045.8 | 1862.5 | 4910.5 | ............... |
| **1888. Digestible.............................** | ......... | **196.9** | **838.8** | **1508.6** | **3557.2** | **113.50** |
| Total for two years.............................. | 9.98 | 782.7 | 3921.1 | 3450.9 | 8449.9 | ............... |
| **Total Digestible for two years.....** | ......... | **352.2** | **1607.7** | **2795.2** | **6084.0** | **205.65** |
| **Average Amounts of Digestible Food and value per Ton of Lucern Hay.....** | | **35.3** | **161.1** | **280.1** | **609.6** | **20.60** |
| **Average Amounts of Digestible Food and value per Ton of Clover Hay......** | | **33.6** | **316.6** | **167.0** | **569.0** | **14.20** |
| **Average Amounts of Digestible Food and value per Ton of Timothy Hay...** | | **24.4** | **357.0** | **68.0** | **566.4** | **12.40** |

The above table shows the total and the digestible food per acre secured from the drilled plot in 1887 and 1888, and its feeding value. As a means of ready comparison of yields, and also of feeding value when compared with the principal hay crops grown in New Jersey, a money value has been placed upon the digestible proteine, fat and carbohydrates. The prices assumed are four and three-tenths cents per pound for proteine and fat, and nine-tenths of a cent per pound for carbohydrates, including fiber. The total yield for the two years has an estimated feeding value of over $200, the value of the second crop exceeding that of the first by $21.35. The total yield for the two years is approximately ten tons of dry hay with a feeding value of $20.60 per ton.

In the above table clover and timothy are added as representing, in the case of clover, the hay usually fed upon the farm, and in the case of timothy, the hay very largely sold from it. The table shows that alfalfa hay is, in money value, 45 per cent. better than clover and 66 per cent. better than timothy. The actual feeding value of any one of them, however, depends upon the proper balancing of the different classes of compounds. To secure a good milk ration by the use of timothy hay, proteine must be supplied from some other source in order to secure a ration that will give a sufficient amount of that material without entailing a loss of carbohydrates and fat; clover hay, however, is a fairly good ration in itself and can be economically used without the addition of any one of the classes of compounds mentioned; alfalfa hay, on the other hand, requires the addition of large amounts of both fat and carbohydrates in order to be profitably utilized as a milk ration. This fact renders alfalfa even more serviceable than its valuation would indicate, since, in the management of farms either for dairy purposes or for grain farming, an excess of carbohydrates is secured which in the great majority of cases is wasted, either through lack of proper material from other sources with which to balance the ration, or through ignorance of the real loss incurred.

Under ordinary conditions, two and a half pounds of proteine, four-tenths of a pound of fat, and twelve and a half pounds of carbohydrates can be profitably fed daily to a milk cow of one thousand pounds live weight. One ton of alfalfa hay—containing thirty-five and three-tenths pounds of digestible fat, two hundred and eighty and one-tenth pounds of digestible proteine, and seven hundred and

seventy and seven-tenths pounds of digestible carbohydrates—would furnish sufficient proteine for *one hundred and twelve* days, fat for *eighty-eight* days, and carbohydrates for *sixty-one* days. Therefore, in order to feed this amount of alfalfa economically and profitably, fat sufficient for *twenty-four* days and carbohydrates for *fifty-one* days must be added from some other source. In securing these amounts of fat and carbohydrates, it is impossible to avoid adding proteine to a slight extent, since all farm products, that are of any value for feeding purposes, contain more or less proteine; this addition of proteine, however, may be, and should be, reduced to a minimum by the selection of those materials which contain it in the smallest amounts. Among these may be mentioned field corn stalks, green fodder corn or ensilage, wheat straw, oat straw, root crops, &c.

One ton of field corn stalks—containing seventeen pounds of fat, sixty pounds of proteine, and ten hundred and seventy-six and six-tenths pounds of carbohydrates—would furnish sufficient proteine for twenty-four days, fat for forty days and carbohydrates for eighty-six days. Two tons of a mixture of equal weights of field corn stalks and alfalfa would therefore furnish food sufficient for one hundred and thirty-six days without noticeable loss of any of the digestible compounds.

In the case of corn ensilage, every ton of which contains six pounds of fat, twenty-four and four-tenths pounds of proteine, and two hundred and ninety-six and six-tenths pounds of carbohydrates, three tons would furnish sufficient proteine for twenty-eight days, fat for forty-five days, and carbohydrates for seventy-one days. Four tons of a mixture composed of one ton of alfalfa hay and three tons of ensilage, or green fodder corn, would therefore furnish food sufficient for one hundred and thirty-six days without any appreciable loss. By the aid of the feeding tables, upon subsequent pages, other materials could be substituted which would secure results similar to those in the examples just given.

*Alfalfa, therefore, furnishes the farmer a feeding material rich in proteine, which can be substituted for such waste products as wheat bran, cotton-seed meal, &c., usually bought in order to profitably utilize the excess of carbohydrates.*

## ALFALFA CONSIDERED AS A COLLECTOR OF PLANT-FOOD.

The extraordinary demands made upon available plant-food by a crop of alfalfa were referred to in the annual report of this Station for 1886. These demands are especially noticeable in the case of nitrogen and potash, the crops of 1887 and 1888 together having collected over one-quarter of a ton of each. Including the barnyard manure applied previous to seeding, the total amount of plant-food applied to this crop has not exceeded one hundred and fifty pounds each of nitrogen, phosphoric acid and potash.

It is universally admitted that the mineral constituents of plants, as phosphoric acid, potash, lime, &c., are derived solely and entirely from the soil. In the case of nitrogen, however, it has long been asserted, and is now claimed to be positively proven, that certain leguminous plants, as clover, peas, alfalfa, &c., have the power of assimilating large amounts from the atmosphere, when sufficient phosphoric acid, potash and lime are present in the soil.

Therefore, while it is quite possible that alfalfa, being a deep-rooting plant, could secure all this nitrogen from the soil; the probability that it has secured a large quantity from the air enhances its value as an agricultural plant, *firstly*, because nitrogen is the basis of the compound proteine, the most valuable part of the food product, and *secondly*, because nitrogen is the most costly element in fertilizing compounds.

Alfalfa serves, therefore, not only as a manufacturer of the chief element of food, but also as a collector from sources otherwise inaccessible of the most valuable fertilizing agent for a large class of agricultural plants whose only source of nitrogen is in the soil. It acts in the hands of the farmer as an agent for rendering locked-up capital available.

When alfalfa is grown, and its products are properly utilized upon the farm, it cannot be considered an exhaustive crop, but rather as one fulfilling the proper aim of rational agriculture, which is to transform into produce the raw materials at our disposal in the atmosphere and soil.

THE AMOUNT OF PLANT-FOOD COLLECTED FROM ONE ACRE, AND ITS VALUE IN THE FORM OF NITRATE OF SODA, BONE-BLACK SUPERPHOSPHATE AND MURIATE OF POTASH.

| DRILLED PLOT. | POUNDS PER ACRE OF | | | Fertilizing value at present prices. |
|---|---|---|---|---|
| | Nitrogen. | Phosphoric Acid. | Potash. | |
| In 1887 | 253.6 | 45.7 | 286.9 | $57.70 |
| " 1888 | 299.2 | 52.4 | 292.2 | 66.30 |
| **Total** | **552.8** | **98.1** | **586.1** | **124.00** |

The amounts of plant-food gathered by the alfalfa crop in two years are equivalent in nitrogen to that contained in 3,455 pounds of nitrate of soda, in phosphoric acid to that contained in 613 pounds of 16 per cent. available bone-black superphosphate, and in potash to the amount contained in 1,176 pounds of muriate of potash. At the prices of nitrogen, phosphoric acid and potash assumed in estimating the values of commercial fertilizers, these amounts of plant-food would cost $124.00.

# FODDERS AND FEEDS.

This Station has in the past devoted a large portion of time to the study and analysis of fodders and feeds. Feeding trials have also been made both with different farm crops and with waste products largely bought to utilize the coarser materials of the farm. These trials have had for their primary purpose the determining of their proper position in the list of nutrients, at the same time testing the German feeding standards.

Chemical analyses of four hundred and sixty-one samples of fodders and feeds have been made, including nearly all the materials serviceable as food for farm animals. The results of these analyses, showing the composition of the different samples and the variations in the composition of materials of the same kind, have appeared from year to year in the reports of this Station, accompanied by such comments and explanations as were deemed necessary.

There is, however, a continual demand upon the Station, from the farmers of the State, for just such information as this work was intended to furnish, which indicates that the work is appreciated but is not readily used in the form in which it is published. The Station feels warranted, therefore, in making further attempts to render this work available for all.

With this idea in mind, the following tables have been arranged. The first table contains twenty-two samples, and shows the pounds per hundred and per ton of the different digestible food compounds, of the ash and of the fertilizing elements. These samples have been selected as representing the principal feeding-stuffs and also because their percentages of digestibility can be reasonably relied upon.

As a means of comparison as well as to show the *relative value* of the materials both as feed and as fertilizer, money values have been assumed. Proteine and fat have been valued at four and one-third cents, and carbohydrates at nine-tenths of a cent per pound; of the fertilizing ingredients, nitrogen has been valued at sixteen and a half

cents, phosphoric acid at eight cents and potash at four and a quarter cents per pound.

The *actual value* of these food and fertilizer constituents depends upon the degree of skill exercised in their use.

The tabulations represent average analyses secured from a relatively large number of samples; the fodders in all cases were grown in the different counties of the State. Differences in composition are observed between those fodders grown upon soils in a good state of fertility and rich in organic matter and those grown on light and sandy soil; in nearly every case the former are richer in fat and proteine. Great differences are likely to occur also, if hay, corn-fodder, straw, &c., are not cut at the proper time, or not gathered in good condition. The feeds, on the other hand, when properly classified, are reasonably uniform in composition. While these averages are therefore trustworthy in the majority of cases, judgment must be exercised when products used are known to be either extra good or very poor, and use made of tables published on a subsequent page.

## EXPLANATION OF TERMS.

In the analyses, the ingredients of fodders are separated in the five following classes:

CRUDE PROTEINE, CRUDE FAT, CRUDE FIBER, CARBOHYDRATES, ASH.

The following description of these is revised from previous annual reports of this Station. The term *proteine* is used to designate a group of compounds, some of which are well known. The elastic substance which remains when wheat flour is kneaded under water, is, for example, a member of this class; its specific name is *gluten.* The white solid in a hard-boiled egg is another member of this class; it is known as *albumen.* When fresh blood is whipped with a bundle of twigs it coagulates, and the red coloring matter can then be washed out; the white solid remaining is a third member of the class, known under the name of *fibrin.* *Gluten, albumen and fibrin,* while differing widely in appearance, agree closely in chemical composition, each having, in a pure and dry condition, 16 per cent. of nitrogen; this percentage of nitrogen is the characteristic feature of this class.

Fodders and feeds, without exception, contain some member of this group; but as the labor of separating the compound is in many cases

## TABLE OF ANALYSES

FOOD CONSTITUENTS (DIGESTIBLE).

| Number of Analyses Averaged. | SAMPLE. | | Dry Matter. | Crude Fat. | Crude Proteine. | Carbohydrates, Including Fiber. | Estimated Feeding Value per Ton. |
|---|---|---|---|---|---|---|---|
| 6 | Brewers' Grains | lbs. per hundred | ........ | 1.81 | 5.44 | 16.78 | ........ |
| | | lbs. per ton | ........ | 36.20 | 108.80 | 335.60 | $9.30 |
| 11 | Clover Hay | lbs. per hundred | 92.30 | 1.68 | 8.35 | 44.28 | ........ |
| | | lbs. per ton | ........ | 33.60 | 167.00 | 885.60 | 14.20 |
| 7 | Corn Meal | lbs. per hundred | 87.21 | 3.30 | 6.58 | 65.49 | ........ |
| | | lbs. per ton | ........ | 66.00 | 131.60 | 1309.80 | 20.40 |
| 5 | Cotton-Seed Meal | lbs. per hundred | 90.67 | 10.76 | 37.83 | 20.03 | ........ |
| | | lbs. per ton | ........ | 215.20 | 756.60 | 400.60 | 45.50 |
| 11 | Field Corn Stalks | lbs. per hundred | 90.29 | 0.85 | 3.00 | 53.83 | ........ |
| | | lbs. per ton | ........ | 17.00 | 60.00 | 1076.60 | 13.00 |
| 20 | Fodder Corn—Green | lbs. per hundred | ........ | 0.30 | 1.22 | 14.83 | ........ |
| | | lbs. per ton | ........ | 6.00 | 24.40 | 296.60 | 4.00 |
| | Fodder Corn—Dry | lbs. per hundred | ........ | 1.26 | 5.11 | 62.07 | ........ |
| | | lbs. per ton | ........ | 25.20 | 102.20 | 1241.40 | 16.70 |
| 7 | German Millet | lbs. per hundred | 92.25 | 0.87 | 3.95 | 45.69 | ........ |
| | | lbs. per ton | ........ | 17.40 | 79.00 | 913.80 | 12.40 |
| 6 | Linseed Meal—Old Process | lbs. per hundred | 90.54 | 6.06 | 27.81 | 36.73 | ........ |
| | | lbs. per ton | ........ | 121.20 | 556.20 | 734.60 | 36.00 |
| 2 | Linseed Meal—New Process | lbs. per hundred | 91.39 | 3.45 | 26.83 | 44.19 | ........ |
| | | lbs. per ton | ........ | 69.00 | 536.60 | 883.80 | 34.20 |
| 17 | Lucern—Green | lbs. per hundred | ........ | 0.40 | 3.65 | 10.54 | ........ |
| | | lbs. per ton | ........ | 8.00 | 73.00 | 210.80 | 5.40 |
| | Lucern Hay | lbs. per hundred | 92.30 | 1.46 | 13.33 | 38.48 | ........ |
| | | lbs. per ton | ........ | 29.20 | 266.60 | 769.60 | 19.75 |
| | Malt Sprouts | lbs. per hundred | 89.53 | 1.12 | 11.85 | 60.84 | ........ |
| | | lbs. per ton | ........ | 22.40 | 237.00 | 1216.80 | 22.20 |
| 8 | Oats—Ground | lbs. per hundred | 88.83 | 3.90 | 9.83 | 49.31 | ........ |
| | | lbs. per ton | ........ | 78.00 | 196.60 | 986.20 | 20.80 |
| 7 | Oat Straw | lbs. per hundred | 91.94 | 0.64 | 1.53 | 40.93 | ........ |
| | | lbs. per ton | ........ | 12.80 | 30.60 | 818.60 | 9.25 |
| 3 | Orchard Grass | lbs. per hundred | 93.00 | 0.89 | 2.97 | 47.72 | ........ |
| | | lbs. per ton | ........ | 17.80 | 59.40 | 954.40 | 11.90 |
| 6 | Rye Straw | lbs. per hundred | 93.36 | 0.40 | 0.78 | 49.92 | ........ |
| | | lbs. per ton | ........ | 8.00 | 15.60 | 998.40 | 10.00 |
| 10 | Timothy Hay | lbs. per hundred | 92.88 | 0.88 | 3.56 | 48.70 | ........ |
| | | lbs. per ton | ........ | 17.60 | 71.20 | 974.00 | 12.60 |
| 6 | Wheat Bran | lbs. per hundred | 87.91 | 3.22 | 13.35 | 45.84 | ........ |
| | | lbs. per ton | ........ | 64.40 | 267.00 | 916.80 | 22.70 |
| 2 | Wheat Chaff | lbs. per hundred | 93.00 | 0.39 | 1.09 | 34.69 | ........ |
| | | lbs. per ton | ........ | 7.80 | 21.80 | 693.80 | 7.50 |
| 11 | Wheat Middlings | lbs. per hundred | 87.83 | 2.78 | 13.09 | 49.90 | ........ |
| | | lbs. per ton | ........ | 55.60 | 261.80 | 998.00 | 23.00 |
| 5 | Wheat Straw | lbs. per hundred | 93.00 | 0.41 | 0.65 | 38.37 | ........ |
| | | lbs. per ton | ........ | 8.20 | 13.00 | 767.40 | 7.81 |

## OF FODDERS AND FEEDS.

FERTILIZER CONSTITUENTS.

| Number of Analyses Averaged. | SAMPLE. | | Ash. | Nitrogen. | Phosphoric Acid. | Potash. | Fertilizing Value per Ton at Present Prices. |
|---|---|---|---|---|---|---|---|
| 6 | Brewers' Grains | lbs. per hundred | 1.51 | 0.11 | 0.31 | 0.05 | ........ |
| | | lbs. per ton | 30.20 | 2.20 | 6.20 | 1.00 | $0.90 |
| 11 | Clover Hay | lbs. per hundred | 6.80 | 1.99 | 0.36 | 1.68 | ........ |
| | | lbs. per ton | 136.00 | 39.80 | 7.20 | 33.60 | 8.60 |
| 7 | Corn Meal | lbs. per hundred | 1.41 | 1.45 | 0.62 | 0.39 | ........ |
| | | lbs. per ton | 28.20 | 29.00 | 12.40 | 7.80 | 6.10 |
| 5 | Cotton-Seed Meal | lbs. per hundred | 7.35 | 6.93 | 3.28 | 1.91 | ........ |
| | | lbs. per ton | 147.00 | 138.60 | 75.60 | 38.20 | 30.50 |
| 11 | Field Corn Stalks | lbs. per hundred | 5.98 | 0.94 | 0.26 | 1.02 | ........ |
| | | lbs. per ton | 119.60 | 18.80 | 5.20 | 20.40 | 4.40 |
| 20 | Fodder Corn—Green | lbs. per hundred | 1.49 | 0.29 | 0.11 | 0.36 | ........ |
| | | lbs. per ton | 29.80 | 5.80 | 2.20 | 7.20 | 1.40 |
| | Fodder Corn—Dry | lbs. per hundred | 6.24 | 1.21 | 0.46 | 1.51 | ........ |
| | | lbs. per ton | 124.80 | 24.20 | 9.20 | 30.20 | 6.00 |
| 7 | German Millet | lbs. per hundred | 6.18 | 1.21 | 0.35 | 1.29 | ........ |
| | | lbs. per ton | 123.60 | 24.20 | 7.00 | 25.80 | 5.70 |
| 6 | Linseed Meal—Old Process | lbs. per hundred | 5.76 | 5.45 | 2.08 | 1.47 | ........ |
| | | lbs. per ton | 115.20 | 109.00 | 41.60 | 29.40 | 22.60 |
| 2 | Linseed Meal—New Process | lbs. per hundred | 6.04 | 5.71 | 2.22 | 1.59 | ........ |
| | | lbs. per ton | 120.80 | 114.20 | 44.40 | 31.80 | 23.75 |
| 17 | Lucern—Green | lbs. per hundred | 2.21 | 0.72 | 0.12 | 0.67 | ........ |
| | | lbs. per ton | 44.20 | 14.40 | 2.40 | 13.40 | 3.15 |
| | Lucern Hay | lbs. per hundred | 8.07 | 2.63 | 0.41 | 2.45 | ........ |
| | | lbs. per ton | 161.40 | 52.60 | 8.20 | 49.00 | 11.40 |
| | Malt Sprouts | lbs. per hundred | 12.48 | 3.97 | 1.46 | 1.65 | ........ |
| | | lbs. per ton | 249.60 | 79.40 | 29.20 | 33.00 | 16.80 |
| 8 | Oats—Ground | lbs. per hundred | 3.37 | 1.86 | 0.77 | 0.59 | ........ |
| | | lbs. per ton | 67.40 | 37.20 | 15.40 | 11.80 | 7.90 |
| 7 | Oat Straw | lbs. per hundred | 4.75 | 0.65 | 0.22 | 1.22 | ........ |
| | | lbs. per ton | 95.00 | 13.00 | 4.40 | 24.40 | 3.50 |
| 3 | Orchard Grass | lbs. per hundred | 5.17 | 0.91 | 0.28 | 1.64 | ........ |
| | | lbs. per ton | 103.40 | 18.20 | 5.60 | 32.80 | 4.80 |
| 6 | Rye Straw | lbs. per hundred | 3.25 | 0.50 | 0.29 | 0.79 | ........ |
| | | lbs. per ton | 65.00 | 10.00 | 5.80 | 15.80 | 2.80 |
| 10 | Timothy Hay | lbs. per hundred | 4.32 | 1.00 | 0.36 | 1.30 | ........ |
| | | lbs. per ton | 86.40 | 20.00 | 7.20 | 26.00 | 5.00 |
| 6 | Wheat Bran | lbs. per hundred | 6.05 | 2.45 | 2.92 | 1.59 | ........ |
| | | lbs. per ton | 121.00 | 49.00 | 58.40 | 31.80 | 14.10 |
| 2 | Wheat Chaff | lbs. per hundred | 7.18 | 0.68 | 0.95 | 0.56 | ........ |
| | | lbs. per ton | 143.60 | 13.60 | 19.00 | 11.20 | 4.24 |
| 11 | Wheat Middlings | lbs. per hundred | 2.43 | 2.38 | 1.21 | 0.65 | ........ |
| | | lbs. per ton | 48.60 | 47.60 | 24.20 | 13.00 | 10.30 |
| 5 | Wheat Straw | lbs. per hundred | 3.45 | 0.51 | 0.09 | 0.74 | ........ |
| | | lbs. per ton | 69.00 | 10.20 | 1.80 | 14.80 | 2.50 |

considerable, and in some cases excessive, the usual plan of making an analysis is simply to determine the percentage of nitrogen, and secure the percentage of proteine by multiplying by $6\frac{1}{4}$.

The class of compounds known as *fats* also differ widely in appearance; butter, lard and tallow are solid at ordinary temperatures, and olive oil and cotton-seed oil, fluid. In chemical composition all are closely allied, and while insoluble in water, are all readily soluble in certain re-agents, as ether, &c. In fodder analysis all substances soluble in ether are grouped as *crude fats*.

Paper pulp and cotton lint are two of the best examples of the class of *crude fiber*, and sugar and starch of the class *carbohydrates*.

*Ash* signifies the residue remaining when a fodder or feed has been burned. It contains the mineral matters extracted by the growing plant from the soil, and in composition varies, of course, with the nature of the fodders. Without exception, however, it contains phosphoric acid, potash, lime, magnesia, soda, sulphuric acid, &c., all of which are substances indispensable to animal life.

## FEEDING STANDARDS.

The animal body has been demonstrated to consist essentially of the ingredients above enumerated, deriving its proteine from the digested proteine of the food, its fat from the four classes of nutrients, and the mineral matter of its bones and various soft tissues, from the constituents of the ash. These ingredients, therefore, are essential to the animal body and must be supplied to it as the need for each arises. This need varies with the animal and the nature of its work—whether producing milk, flesh, wool, animal heat or muscular energy. Investigations have consequently been made which have resulted in the formation of feeding standards, viz.: Statements of the amounts of digestible proteine, fat and carbohydrates (including fiber), which have been shown to be best adapted to the various conditions of the animal and the numerous purposes of feeding. A table of feeding standards, based upon data secured from the work of German chemists, is given on the opposite page.

By reference to the table it is observed that the feeding standard for milk cows is $2\frac{1}{2}$ pounds of proteine, $\frac{4}{10}$ of a pound of fat and $12\frac{1}{2}$ pounds of carbohydrates, all included in 24 pounds of dry matter, and giving a nutritive ratio of 1 : 5.4. The nutritive ratio is secured

## TABLE OF FEEDING STANDARDS.

POUNDS PER DAY PER 1,000 POUNDS LIVE WEIGHT.

| KIND OF ANIMAL. | Total dry Organic Matter. | Proteine. | Carbohydrates, including Fiber. | Fat. | Total Nutritive Substances. | Nutritive Ratio. |
|---|---|---|---|---|---|---|
| Horse, at light work | 21.0 | 1.5 | 9.5 | 0.40 | 11.40 | 1:7.0 |
| " average work | 22.5 | 1.8 | 11.2 | 0.60 | 13.60 | 1:7.0 |
| " hard work | 25.5 | 2.8 | 13.4 | 0.80 | 17.00 | 1:5.5 |
| Oxen, at rest in stall | 17.5 | 0.7 | 8.0 | 0.15 | 8.85 | 1:12.0 |
| " ordinary work | 24.0 | 1.6 | 11.3 | 0.30 | 13.20 | 1:7.5 |
| " hard work | 26.0 | 2 4 | 13.2 | 0.50 | 16.10 | 1:6.0 |
| Oxen, fattening, first period | 27.0 | 2.5 | 15.0 | 0.50 | 18.00 | 1:6.5 |
| " " second period | 26.0 | 3.0 | 14.8 | 0.70 | 18.50 | 1:5.5 |
| " " third period | 25.0 | 2.7 | 14.8 | 0.60 | 18.10 | 1:6.0 |
| Milk Cows | 24.0 | 2.5 | 12.5 | 0.40 | 15.40 | 1:5.4 |
| Sheep, wool-producing (coarser breeds) | 20.0 | 1.2 | 10.3 | 0.20 | 11.70 | 1:9.0 |
| " " (finer breeds) | 22.5 | 1.5 | 11.4 | 0.25 | 13.15 | 1:8.0 |
| " fattening, first period | 26.0 | 3.0 | 15.2 | 0.50 | 18.70 | 1:5.5 |
| " " second period | 25.0 | 3.5 | 14.4 | 0.60 | 18.50 | 1:4.5 |
| Swine, fattening, first period | 36.0 | 5.0 | 27.5 | | 32.50 | 1:5.5 |
| " " second period | 31.0 | 4.0 | 24.0 | | 28.00 | 1:6.0 |
| " " third period | 23.5 | 2.7 | 17.5 | | 20.20 | 1:6.5 |
| **GROWING CATTLE.** | | | | | | |
| Age, Months. — Average live weight per head. | | | | | | |
| 2–3 — 150 pounds | 22.0 | 4.0 | 13.8 | 2.0 | 19.8 | 1:4.7 |
| 3–6 — 300 " | 23.4 | 3.2 | 13.5 | 1.0 | 17.7 | 1:5.0 |
| 6–12 — 500 " | 24.0 | 2.5 | 13.5 | 0.6 | 16.6 | 1:6.0 |
| 12–18 — 700 " | 24.0 | 2.0 | 13.0 | 0.4 | 15.4 | 1:7.0 |
| 18–24 — 850 " | 24.0 | 1.6 | 12.0 | 0.3 | 13.9 | 1:8.0 |
| **GROWING SHEEP.** | | | | | | |
| 5–6 — 56 " | 28.0 | 3.2 | 15.6 | 0.8 | 19.6 | 1:5.5 |
| 6–8 — 67 " | 25.0 | 2.7 | 13.3 | 0.6 | 16.6 | 1:5.5 |
| 8–11 — 75 " | 23.0 | 2.1 | 11.4 | 0.5 | 14.0 | 1:6.0 |
| 11–15 — 82 " | 22.5 | 1.7 | 10.9 | 0.4 | 13.0 | 1:7.0 |
| 15–20 — 85 " | 22.0 | 1.4 | 10.4 | 0.3 | 12.1 | 1:8.0 |
| **GROWING PIGS.** | | | | | | |
| 2–3 — 50 " | 42.0 | 7.7 | 30.0 | | 37.5 | 1:4.0 |
| 3–5 — 100 " | 34.0 | 5.5 | 25.0 | | 30.0 | 1:5.0 |
| 5–6 — 125 " | 31.5 | 4.3 | 23.7 | | 28.4 | 1:5.5 |
| 6–8 — 170 " | 27.0 | 3.4 | 20.4 | | 23.8 | 1:6.0 |
| 8–12 — 250 " | 21.0 | 2.5 | 16.2 | | 18.7 | 1:6.5 |

by multiplying the amount of fat by $2\frac{1}{2}$, adding the carbohydrates and dividing the sum by the amount of proteine, *i. e.* 0.4 multiplied by $2\frac{1}{2}$ equals 1, which added to $12\frac{1}{2}$ equals $13\frac{1}{2}$, this divided by $2\frac{1}{2}$ equals 5.4. Many feeding-stuffs approximate closely enough to the feeding standards given, and the special value of tables of analyses, &c., is recognized only when those materials are not at hand or when it is desirable from any cause to change the diet.

## UTILITY OF THE TABLES.

The following examples are given to illustrate the utility of the tables:

1. It is desired to feed 15 milk cows for 100 days. The table of feeding standards shows that this will require 600 pounds of fat, 3,750 pounds of proteine and 18,750 pounds of carbohydrates. There is available 6 tons of cornstalks, 5 tons of clover hay and 3 tons of oat straw, which the table of analyses shows to contain 308 pounds of fat, 1,287 pounds of proteine and 13,340 pounds of carbohydrates. Too little of all the ingredients is contained in the materials at hand. A simple subtraction shows that there must be secured from other sources 292 pounds of fat, 2,463 pounds of proteine and 5,410 pounds of carbohydrates. Feeds must be added, therefore, which are relatively high in proteine and fat, and low in carbohydrates. Of such feeds, cotton-seed meal, linseed meal, wheat bran, malt sprouts and wheat middlings are good examples, and any or all of these, if added in proper proportions, will give the desired food, and a ration corresponding to the feeding standard. For instance, the food required in order to furnish a balanced ration for the time mentioned, may be secured from 3.7 tons of new-process linseed meal and 2 tons of malt sprouts, as follows:

| | Digestible Fat. | Digestible Proteine. | Digestible Carbohydrates. |
|---|---|---|---|
| 6 tons corn stalks.... / 5 " clover hay.... / 3 " oat straw...... } on hand......... | 308 pounds. | 1,287 pounds. | 13,340 pounds. |
| 3.7 " N. P. linseed meal, added........ | 255 " | 1,985 " | 3,270 " |
| 2 " malt sprouts, added................ | 44 " | 478 " | 2,433 " |
| Total for 15 cows for 100 days.......... | 607 " | 3,750 " | 18,943 " |
| " " 1 cow for 1 day................ | 0.40 " | 2.50 " | 12.63 " |

This ration compares with the theoretical ration, as follows:

| | Digestible Fat. | Digestible Proteine. | Digestible Carbohydrates. |
|---|---|---|---|
| Total for 15 cows for 100 days........... | 600 pounds. | 3,750 pounds. | 18,750 pounds. |
| " " 1 cow for 1 day................ | 0.40 " | 2.50 " | 12.50 " |

2. A dairy herd of 47 cows, averaging 1,000 pounds live weight, is fed daily the following mixed ration. Required to know if it agrees with the feeding standard for milk cows, and if it does not, what changes are necessary to be made:

| Ration consisting of: | | Digestible Fat. | Digestible Proteine. | Digestible Carbohydrates. |
|---|---|---|---|---|
| 600 lbs. brewers' grains.. | Containing........ | 10.86 lbs. | 32.64 lbs. | 100.68 lbs. |
| 250 " corn meal......... | | 8.25 " | 16.45 " | 163.72 " |
| 300 " wheat bran...... | | 9.66 " | 40.05 " | 137.52 " |
| 160 " field corn stalks | | 1.36 " | 4.80 " | 86.12 " |
| 125 " clover hay........ | | 2.10 " | 10 44 " | 55.35 " |
| 50 " wheat chaff...... | | .19 " | .55 " | 17.34 " |
| Total for 47 cows per day................................ | | 32.42 " | 104 93 " | 560.73 " |
| " " 1 cow " " ................................ | | .69 " | 2.23 " | 11.93 " |

The calculation, by means of the tables, of the amount of digestible fat, proteine and carbohydrates which these materials contain, has been placed opposite the ration; it shows that the ration contains too little proteine and carbohydrates, and too much fat. To get sufficient proteine and carbohydrates it is obvious that some fat will be added also; nevertheless, care should be taken to select materials containing a minimum amount of that ingredient. A slight excess of fat will not materially influence the economic value of the ration, provided sufficient proteine is present.

An addition of fifty pounds of new-process linseed meal would give:

| | Digestible Fat. | Digestible Proteine. | Digestible Carbohydrates. |
|---|---|---|---|
| Total for 47 cows per day............... | 34.2 pounds. | 118.35 pounds. | 582.83 pounds. |
| " " 1 cow " " ............... | .73 " | 2.52 " | 12.40 " |

The nutritive ratio is a trifle wide, owing to the excess of fat; still, for practical purposes, it may be considered quite close enough to the standard ration. For feeding standards must not be regarded as inflexible rules to be blindly followed, but guides and indications which must be intelligently adapted to local and individual circumstances.

The above question was recently asked by a farmer of this State, and the answer is substantially as given him. Tables giving the

## THE MAXIMUM, MINIMUM AND AVERAGE COMPOSITION OF FODDERS.

| Brand. | From the Report of | No. of Analyses. | Dry Matter. | | | Proteine. | | | Fat. | | | Carbohydrates or Nitrogen—Free Extract. | | | Crude Fiber. | | | Ash. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Average. |
| Clover Hay...... | Professor Julius Kuhn.............. | ...... | 77.10 | 90.00 | 83.30 | 7.20 | 15.80 | 11.00 | 1.20 | 5.50 | 3.20 | 22.30 | 39.70 | 32.90 | 19.50 | 43.00 | 29.90 | 6.30 |
| | Dr. E. H. Jenkins, Conn. Station. | 12 | 78.18 | 91.53 | 84.98 | 8.87 | 13.06 | 11.38 | 1.47 | 3.10 | 1.98 | 35.03 | 45.47 | 40.11 | 23.79 | 28.64 | 26.35 | 5.15 |
| | New Jersey Station.................... | 11 | 91.48 | 93.89 | 92.30 | 10.31 | 14.06 | 12.46 | 1.64 | 2.87 | 2.08 | 39.27 | 49.03 | 42.77 | 23.74 | 35.65 | 28.20 | 6.80 |
| Timothy Hay... | Professor Julius Kuhn................ | ... .. | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... |
| | Dr. E. H. Jenkins, Conn. Station. | 18 | 85.70 | 91.30 | 87.42 | 4.88 | 9.60 | 6.36 | 1.08 | 3.30 | 2.03 | 41.09 | 48.58 | 44.89 | 22.70 | 34.25 | 29.93 | 4.23 |
| | New Jersey Station.................... | 10 | 91.33 | 93.88 | 92.88 | 3.75 | 9.19 | 6.25 | 1.52 | 2.32 | 1.83 | 46.02 | 57.09 | 51.69 | 24.55 | 31.28 | 28.73 | 4 32 |
| Lucern ............ | Professor Julius Kuhn............... | ...... | 80.80 | 87.50 | 83.80 | 13.1 | 19.7 | 14.40 | 2.30 | 3.80 | 2.50 | 20.00 | 34.80 | 27.90 | 19.30 | 40.00 | 33.00 | 6.00 |
| | Dr. E. H. Jenkins, Conn. Station. | ...... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... |
| | New Jersey Station.................... | 3 | 92.45 | 94.34 | 93.52 | 15.00 | 18.56 | 17.04 | 1.80 | 2.40 | 2.05 | 35.45 | 39.22 | 37.11 | 26.22 | 33.04 | 30.34 | 7.10 |
| Millet............... | Professor Julius Kuhn............... | ...... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... |
| | Dr. E. H. Jenkins, Conn. Station. | 8 | ......... | ......... | 83.30 | 5.56 | 10.67 | 6.59 | 1.30 | 2.14 | 1.81 | 34.85 | 44.71 | 42.49 | 26.18 | 28.94 | 27.16 | 5.24 |
| | New Jersey Station.................... | 7 | 90.95 | 93.22 | 92.25 | 5.00 | 12.25 | 7.59 | 1 45 | 2.19 | 1.78 | 44.42 | 52.97 | 49.19 | 23.58 | 30.25 | 27.53 | 6.18 |
| Salt Marsh Hay | Professor Julius Kuhn...... ......... | ...... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... |
| | Dr. E. H. Jenkins, Conn. Station. | 11 | 81.40 | 92.80 | 89.53 | 4.30 | 7.80 | 5.90 | 1.63 | 3.10 | 2.32 | 34.10 | 53.67 | 42.42 | 27.00 | 37.90 | 31.47 | 7.42 |
| | New Jersey Station.................... | 2 | 91.84 | 91.94 | 91.89 | 4.00 | 5.13 | 4.57 | 2.11 | 2.42 | 2.26 | 52.38 | 54.32 | 53.35 | 25.08 | 25.27 | 25.18 | 6.53 |

## THE MAXIMUM, MINIMUM AND AVERAGE COMPOSITION OF FODDERS.

| Brand. | From the Report of | No. of Analyses. | Dry Matter. | | | Proteine. | | | Fat. | | | Carbohydrates or Nitrogen—Free Extract. | | | Crude Fiber. | | | Ash. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Average. |
| Corn Stalks...... | Professor Julius Kuhn.............. | ...... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... |
| | Dr. E. H. Jenkins, Conn. Station. | 6 | 60.63 | 77.07 | 67.95 | 3.39 | 4.97 | 4.29 | 0.66 | 1.56 | 1.24 | 30.52 | 40.82 | 35.96 | 18.65 | 25.18 | 22.14 | 4.32 |
| | New Jersey Station.................... | 11 | 78.33 | 92.43 | 90.29 | 3.63 | 9.56 | 5.91 | 0.87 | 1.95 | 1.26 | 43.67 | 57.47 | 49.69 | 23.61 | 30.31 | 27.46 | 5.98 |
| Wheat Straw... | Professor Julius Kuhn.............. | ...... | 74.00 | 91.90 | 85.70 | 1.40 | 5.60 | 3.10 | 0.60 | 2.00 | 1.20 | 26.70 | 44.40 | 37.50 | 28.90 | 52.60 | 40.00 | 3.90 |
| | Dr. E. H. Jenkins, Conn. Station. | 2 | 88.63 | 92.22 | 90.43 | 2.19 | 2.56 | 2.37 | 1.24 | 2.53 | 1.89 | 41.51 | 47.01 | 44.27 | 37.32 | 40.05 | 38.68 | 3.22 |
| | New Jersey Station.................... | 4 | 92.37 | 93.16 | 92.92 | 2.94 | 3.63 | 3.19 | 0.81 | 1.82 | 1.27 | 47.42 | 50.56 | 49.23 | 34.30 | 37.62 | 35.78 | 3.45 |
| Rye Straw........ | Professor Julius Kuhn.............. | ...... | 81.40 | 89.70 | 85.70 | 1.50 | 4.60 | 3.00 | 1.10 | 2.50 | 1.30 | 23.40 | 44.50 | 33.30 | 30.10 | 54.90 | 44.00 | 4.10 |
| | Dr. E. H. Jenkins, Conn. Station. | 1 | ......... | ......... | 87.50 | ......... | ......... | 6.89 | ......... | ......... | 2.68 | ......... | ......... | 35.70 | ......... | ......... | 34.20 | 8.03 |
| | New Jersey Station .................. | 6 | 92.85 | 93.70 | 93.36 | 2.75 | 3.63 | 3.11 | 1.15 | 1.58 | 1.25 | 44.54 | 52.88 | 47.53 | 32.70 | 41.52 | 38.22 | 3.25 |
| Oats Straw....... | Professor Julius Kuhn.............. | ...... | 78.80 | 89.70 | 85.70 | 1.30 | 7.00 | 4.00 | 1.00 | 5.10 | 2.00 | 24.90 | 48.90 | 35.60 | 30.00 | 50.20 | 39.70 | 4.40 |
| | Dr. E. H. Jenkins, Conn. Station. | 3 | 87.50 | 93.47 | 89.89 | 2.30 | 5.08 | 3.35 | 1.00 | 3.15 | 2.07 | 26.42 | 44.26 | 36.97 | 35.21 | 55.96 | 42.78 | 4.72 |
| | New Jersey Station.................... | 7 | 88.58 | 92.87 | 91.94 | 3.06 | 6.88 | 4.04 | 1.72 | 2.73 | 2.12 | 42.10 | 51.41 | 44.71 | 29.52 | 41.80 | 36.33 | 4.75 |
| Buckwheat Straw. | Professor Julius Kuhn.............. | ...... | 84.50 | 90.30 | 87.90 | 3.10 | 5.50 | 4.10 | 1.30 | 1.60 | 1.40 | 29.90 | 37.10 | 32.90 | 35.30 | 51.80 | 44.30 | 5.20 |
| | Dr. E. H. Jenkins, Conn. Station. | 2 | 89.50 | 89.60 | 89.55 | 3.33 | 4.38 | 3.85 | 1.42 | 1.70 | 1.56 | 32.08 | 34.49 | 33.28 | 44.93 | 46.83 | 45.88 | 5.05 |
| | New Jersey Station.................... | 1 | ......... | ......... | 89.02 | ......... | ......... | 7.75 | ......... | ......... | 0.65 | ......... | ......... | 38.93 | ......... | ......... | 37.16 | 6.51 |

## THE MAXIMUM, MINIMUM AND AVERAGE COMPOSITION OF FEEDS.

| Brand. | From the Report of | No. of Analyses. | Dry Matter. | | | Proteine. | | | Fat. | | | Carbohydrates or Nitrogen—Free Extract. | | | Crude Fiber. | | | Ash. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Average. |
| Corn Meal, all Varieties...... | Professor Julius Kuhn................ | ...... | 77.60 | 91.80 | 87.30 | 5.80 | 15.10 | 10.60 | 1.50 | 9.20 | 6.50 | 52.40 | 72.70 | 65.70 | 1.30 | 8.50 | 2.80 | 1.70 |
| | Dr. E. H. Jenkins, Conn. Station. | 176 | 79.30 | 94.02 | 89.51 | 7.00 | 15.31 | 10.62 | 3.40 | 7.13 | 5.49 | 61.78 | 75.73 | 69.72 | 0.78 | 5.24 | 2.13 | 1.55 |
| | New Jersey Station..................... | 7 | 86.43 | 88.25 | 87.21 | 8.63 | 9.44 | 9.09 | 3.62 | 4.55 | 4.08 | ......... | .. ...... | ......... | ......... | ......... | ......... | 1.37 |
| Western Corn... | Professor Julius Kuhn................ | ...... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... |
| | Dr. E. H. Jenkins, Conn. Station. | 3 | 79.30 | 83.60 | 80.90 | 7.80 | 8.60 | 8.30 | 3.60 | 3.90 | 3.70 | 64.90 | 68.20 | 66.00 | 1.70 | 1.80 | 1.75 | 1.20 |
| | New Jersey Station..................... | 3 | 87.21 | 88.21 | 87.80 | 8.31 | 9.56 | 8.97 | 3.95 | 4.11 | 4.02 | ......... | ......... | ......... | ......... | ......... | ......... | 1.53 |
| Flint Corn........ | Professor Julius Kuhn. .............. | ...... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... |
| | Dr. E. H. Jenkins, Conn. Station. | 63 | 81.84 | 93.41 | 88.93 | 7.00 | 13.65 | 10.67 | 3.40 | 7.13 | 5.00 | 67.95 | 74.62 | 70.08 | 0.78 | 2.88 | 1.71 | 1.47 |
| | New Jersey Station..................... | 5 | 86.95 | 90.42 | 88.69 | 8.88 | 10.44 | 9.62 | 3.09 | 4.82 | 4.18 | ......... | ......... | ......... | ......... | ......... | ......... | 1.44 |
| Dent Corn........ | ................................................ | ...... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... |
| | Dr. E. H. Jenkins, Conn. Station. | 77 | 85.95 | 93.78 | 89.93 | 7.53 | 12.07 | 10.36 | 3.80 | 6.93 | 5.15 | 66.26 | 75.73 | 70.60 | 1.25 | 4.81 | 2.29 | 1.53 |
| | New Jersey Station..................... | 2 | 86.07 | 86.89 | 86.48 | 8.56 | 8.75 | 8.65 | 3.18 | 4.65 | 3.92 | ......... | ......... | ......... | ......... | ......... | ......... | 1.24 |
| Oats ................ | Professor Julius Kuhn................ | ...... | 83.60 | 92.40 | 86.30 | 6.30 | 18.50 | 12.00 | 4.40 | 7.30 | 6.00 | 48.00 | 71.80 | 56.60 | 4.10 | 16.10 | 9.00 | 2.70 |
| | Dr. E. H. Jenkins, Conn. Station. | 21 | 86.50 | 91.10 | 89.30 | 8.00 | 14.40 | 11.30 | 4.10 | 5.80 | 5.00 | 57.10 | 66.90 | 61.00 | 1.50 | 12.90 | 9.00 | 3.00 |
| | New Jersey Station..................... | 8 | 88.48 | 89.32 | 88.83 | 9.00 | 12.88 | 11.36 | 4.57 | 5.97 | 5.17 | ......... | ......... | ......... | ......... | ......... | ......... | 3.36 |

## THE MAXIMUM, MINIMUM AND AVERAGE COMPOSITION OF FEEDS.

| Brand. | From the Report of | No. of Analyses. | Dry Matter. | | | Proteine. | | | Fat. | | | Carbohydrates or Nitrogen—Free Extract. | | | Crude Fiber. | | | Ash. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Average. |
| Wheat Bran | Professor Julius Kuhn | ... | 83.50 | 92.40 | 87.00 | 10.10 | 17.00 | 14.50 | 1.70 | 6.60 | 3.50 | 28.50 | 61.50 | 53.60 | 4.10 | 34.60 | 9.40 | 6.00 |
| | Dr. E. H. Jenkins, Conn. Station | 2 | 85.82 | 91.35 | 87.98 | 7.81 | 16.89 | 14.54 | 2.39 | 5.84 | 3.66 | 50.41 | 58.93 | 55.16 | 7.24 | 16.64 | 8.79 | 5.83 |
| | New Jersey Station | 18 | 86.28 | 89.10 | 87.91 | 12.31 | 17.94 | 15.01 | 1.85 | 5.04 | 3.39 | ........ | ........ | ........ | ........ | ........ | ........ | 6.24 |
| Wheat Middlings | Professor Julius Kuhn | ... | 86.00 | 88.50 | 87.10 | 12.60 | 15.20 | 14.60 | 2.60 | 3.30 | 3.00 | 61.60 | 64.90 | 63.80 | 1.40 | 4.80 | 3.10 | 2.60 |
| | Dr. E. H. Jenkins, Conn. Station | 9 | 86.15 | 89.44 | 88.03 | 10.13 | 15.00 | 12.27 | 2.07 | 4.35 | 3.23 | 60.21 | 70.86 | 65.48 | 3.47 | 7.45 | 4.58 | 2.47 |
| | New Jersey Station | 11 | 86.34 | 90.18 | 87.83 | 12.94 | 16.88 | 14.92 | 2.52 | 3.92 | 3.29 | ........ | ........ | ........ | ........ | ........ | ........ | 2.54 |
| Wheat Shorts | Professor Julius Kuhn | ... | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| | Dr. E. H. Jenkins, Conn. Station | 6 | 86.41 | 89.04 | 88.15 | 11.13 | 15.13 | 13.14 | 2.50 | 4.85 | 3.79 | 55.62 | 62.32 | 58.96 | 6.34 | 10.47 | 7.94 | 4.32 |
| | New Jersey Station | 4 | 87.61 | 88.57 | 87.94 | 13.44 | 16.13 | 14.56 | 2.77 | 3.69 | 3.32 | ........ | ........ | ........ | ........ | ........ | ........ | 2.14 |
| Rye | Professor Julius Kuhn | ... | 81.70 | 91.40 | 85.70 | 7.90 | 17.40 | 11.40 | 0.90 | 2.80 | 1.70 | 62.50 | 72.40 | 67.80 | 1.10 | 6.70 | 3.00 | 1.80 |
| | Dr. E. H. Jenkins, Conn. Station | 6 | 86.80 | 91.30 | 88.40 | 9.50 | 12.10 | 10.60 | 1.40 | 2.10 | 1.70 | 70.70 | 73.90 | 72.60 | 1.40 | 2.10 | 1.60 | 1.90 |
| | New Jersey Station | 6 | 86.78 | 90.85 | 87.97 | 9.06 | 11.69 | 10.16 | 1.55 | 2.00 | 1.71 | ........ | ........ | ........ | ........ | ........ | ........ | 1.84 |
| Rye Bran | ........ | ... | 81.60 | 93.50 | 87.50 | 10.10 | 18.10 | 14.50 | 1.90 | 5.00 | 3.50 | 32.90 | 64.60 | 57.10 | 4.20 | 28.50 | 7.20 | 5.20 |
| | Dr. E. H. Jenkins, Conn. Station | 3 | 86.30 | 89.70 | 87.70 | 12.60 | 16.80 | 15.26 | 1.79 | 2.60 | 2.19 | 59.75 | 67.00 | 63.12 | 2.50 | 4.00 | 3.51 | 3.62 |
| | New Jersey Station | 5 | 86.26 | 89.38 | 87.66 | 12.81 | 14.38 | 13.41 | 1.70 | 3.85 | 2.63 | ........ | ........ | ........ | ........ | ........ | ........ | 2.96 |

## THE MAXIMUM, MINIMUM AND AVERAGE COMPOSITION OF FEEDS.

| BRAND. | FROM THE REPORT OF | No. of Analyses. | DRY MATTER. | | | PROTEINE. | | | FAT. | | | CARBOHYDRATES OR NITROGEN—FREE EXTRACT. | | | CRUDE FIBER. | | | ASH. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Minimum. | Maximum. | Average. | Average. |
| Buckwheat Flour | Professor Julius Kuhn | ... | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| | Dr. E. H. Jenkins, Conn. Station. | 3 | 85.06 | 87.[illegible] | 86.48 | 4.18 | 8.00 | 6.48 | 0.65 | 1.74 | 1.33 | 75.81 | 79.83 | 77.34 | 0.21 | 0.35 | 0.28 | 1.05 |
| | New Jersey Station | 2 | 83.81 | 84.18 | 84.00 | 3.88 | 4.19 | 4.03 | 0.63 | 0.64 | 0.64 | ........ | ........ | ........ | ........ | ........ | ........ | 0.52 |
| Linseed Meal | Professor Julius Kuhn | ... | 81.10 | 92.90 | 87.80 | 20.60 | 37.80 | 29.50 | 6.00 | 18.20 | 10.00 | 19.70 | 41.30 | 29.80 | 5.10 | 16.80 | 9.70 | 8.80 |
| | Dr. E. H. Jenkins, Conn. Station | 4 | 87.53 | 93.83 | 91.28 | 27.68 | 33.95 | 31.23 | 5.16 | 11.57 | 8.72 | 31.45 | 44.89 | 37.75 | 7.12 | 7.57 | 7.34 | 6.24 |
| | New Jersey Station | 6 | 89.48 | 93.31 | 90.54 | 31.81 | 34.25 | 32.80 | 6.69 | 7.80 | 7.41 | ........ | ........ | ........ | ........ | ........ | ........ | 5.84 |
| Linseed Meal, New Process. | Professor Julius Kuhn | ... | 85.40 | 90.30 | 88.00 | 24.90 | 35.10 | 32.70 | 0.70 | 3.80 | 2.30 | 24.50 | 39.90 | 36.40 | 6.70 | 10.80 | 8.80 | 7.80 |
| | Dr. E. H. Jenkins, Conn. Station. | 6 | 86.65 | 93.21 | 89.49 | 27.10 | 37.10 | 33.45 | 1.30 | 4.01 | 2.83 | 35.22 | 48.03 | 38.78 | 7.58 | 9.00 | 8.37 | 6.06 |
| | New Jersey Station | 1 | ........ | ........ | 91.39 | ........ | ........ | 35.69 | ........ | ........ | 2.35 | ........ | ........ | ........ | ........ | ........ | ........ | 6.04 |
| Cotton-Seed Meal | Professor Julius Kuhn | ... | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| | Dr. E. H. Jenkins, Conn. Station. | 22 | 90.87 | 94.32 | 92.17 | 22.27 | 50.81 | 42.45 | 10.24 | 18.01 | 13.36 | 12.74 | 38.68 | 23.49 | 2.77 | 11.76 | 5.67 | 7.20 |
| | New Jersey Station | 2 | 89.33 | 92.01 | 90.67 | 43.25 | 44.31 | 43.79 | 10.39 | 12.88 | 11.63 | ........ | ........ | ........ | ........ | ........ | ........ | 6.53 |
| Flax-Seed Meal | Professor Julius Kuhn | ... | 87.70 | 93.20 | 88.20 | 20.00 | 28.50 | 21.70 | 21.70 | 39.00 | 35.60 | 9.00 | 35.70 | 19.60 | 3.20 | 18.00 | 7.90 | 3.40 |
| | Dr. E. H. Jenkins, Conn. Station. | ... | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| | New Jersey Station | 2 | 91.28 | 92.23 | 91.71 | 22.31 | 25.75 | 24.03 | 31.69 | 33.57 | 32.63 | ........ | ........ | ........ | ........ | ........ | ........ | 4.03 |

composition of foods and their digestibility are in every-day use in some countries, and are recognized as highly serviceable.

The table on pages 116 and 117 shows also the amount of nitrogen, ash, phosphoric acid and potash contained in the fodders and feeds. By its aid farmers are enabled to keep an account of the amount of fertilizing material exported from and imported to the farm.

As before stated, money values have been assumed largely as a means of comparison, although the prices placed upon the ingredients are those used in estimating values of commercial fertilizers.

With the exception of the amounts of nitrogen, phosphoric acid and potash sold from the farm in the shape of milk and animal product, the entire amounts of phosphoric acid and potash and nearly all of the nitrogen contained in the materials fed, are found in the liquid and solid excrements of the animal. Consequently, the degree to which a farmer secures the estimated fertilizing value of his feeding-stuffs, depends upon the care that he takes in properly saving and using these excrements.

The above five tables, containing the classified analyses of fodders and feeds made at this Station, compared with similar analyses secured by Professor Julius Kuhn, of Halle, Germany, and by Dr. E. H. Jenkins, of the Connecticut Experiment Station, are republished from the annual reports of this Station for 1885 and 1886. They indicate the absolute amounts of fat, proteine, carbohydrates and fiber present in the feeding-stuffs, without reference to digestibility. The table on the following page is added, therefore, in order to show what percentages are digestible, of the amounts of fat, proteine, carbohydrates and fiber actually present.

The especial value of these tables at this time lies in the fact that they give the highest and lowest amounts of the different constituents which were found in all the analyses made, and therefore show the analytical range of each feeding-stuff, as it varies from extra good to very poor. When material, for instance, is, in the judgment of the farmer, at either extreme in quality, and is to be used with other stuffs in a mixed ration, the utility of these tables becomes apparent; for in such a case the proportions should be based, not upon the average analysis as given on page 116, but upon the analysis which these tables give in either the maximum or minimum column.

## DIGESTIBILITY OF FEEDING-STUFFS.

(DIGESTION CO-EFFICIENTS.)

| KIND OF MATERIAL. | Fat. | Fiber. | Proteine. | Carbohydrates. |
|---|---|---|---|---|
| Brewers' Grains | 84. | 39. | 73. | 64. |
| Clover Hay | 60. | 47. | 62. | 70. |
| Corn, Indian | 85. | 62. | 79. | 91. |
| Cornstalks | 75. | 72. | 73. | 67. |
| Cotton-Seed Meal | 88. | ........ | 85. | 95. |
| Linseed Meal | 91. | ........ | 82. | 73. |
| Lucern | 39. | 43. | 74. | 66. |
| Malt Sprouts | 49. | 95. | 82. | 88. |
| Oats | 82. | 17. | 77. | 74. |
| Oat Straw | 30. | 60. | 41. | 46. |
| Rye Bran | 58. | 4. | 66. | 75. |
| Rye Straw | 32. | 60. | 21. | 37. |
| Timothy Hay (very good) | 50. | 62. | 64. | 68. |
| " " (medium) | 48. | 58. | 57. | 62. |
| " " (inferior) | 41. | 54. | 51. | 58. |
| Wheat Bran | 69. | 33. | 78. | 77. |
| Wheat Straw | 36. | 56. | 17. | 39. |

For example, should it be desired for the above or any other purpose to know the analysis of timothy hay, it would be determined as follows:

1. *If the material is of inferior quality.* Turning to timothy hay in the preceding tables, the minimum amounts that this Station has found in 100 pounds are seen to be

| | | |
|---|---|---|
| 1.52 | pounds of | fat. |
| 3.75 | " " | proteine. |
| 46.02 | " " | carbohydrates. |
| 24.55 | " " | crude fiber. |

The table of the digestibility of feeding-stuffs shows that in timothy hay of inferior quality about

| | | |
|---|---|---|
| 41 | per cent. of the | fat, |
| 51 | " " " " | proteine, |
| 58 | " " " " | carbohydrates, |
| 54 | " " " " | crude fiber, |

are digestible.

Multiplying the total amounts of the different constituents, as expressed in pounds per hundred (*i. e.* per cent.), by their percentage of digestibility or "digestion co-efficients," gives the actual amounts of digestible matter in 100 pounds, and this again multiplied by 20 will give the amounts of digestible fat, proteine, &c., in 2,000 pounds or one ton of inferior timothy hay, thus:

| | | | |
|---|---|---|---|
| Digestible fat | $1.52 \times .41 = 0.62$ | $\times 20 =$ | 12.4 pounds. |
| Digestible proteine | $3.75 \times .51 = 1.91$ | $\times 20 =$ | . 38.2 " |
| Digestible carbohydrates | $46.02 \times .58 = 26.69$ | $\times 20 =$ | 533.8 " |
| Digestible fiber | $24.55 \times .54 = 13.26$ | $\times 20 =$ | 265.2 " |

Adding the digestible carbohydrates and fiber together, the analysis of inferior timothy hay would, therefore, be

| | | |
|---|---|---|
| 12.4 | pounds of digestible | fat per ton. |
| 38.2 | " " " | proteine per ton. |
| 799.0 | " " " | carbohydrates and fiber per ton. |

2. *If the material is of superior quality.* Again turning to timothy hay in the preceding tables, the maximum amounts found by this Station in 100 pounds must now be used. These are

| | | |
|---|---|---|
| 2.32 | pounds of | fat, |
| 9.19 | " " | proteine, |
| 57.09 | " " | carbohydrates, |
| 31.28 | " " | crude fiber. |

Consulting the table of digestibility of feeding-stuffs again, we learn that in timothy hay which is very good,

| | | |
|---|---|---|
| 50 | per cent. of the | fat, |
| 64 | " " " " | proteine, |
| 68 | " " " " | carbohydrates, |
| 62 | " " " " | crude fiber, |

are digestible.

Multiplying the pounds per hundred by the digestion co-efficients, as in the preceding case, and multiplying again by 20, gives the amounts of digestible matter in one ton of superior hay, thus:

| | | | |
|---|---|---|---|
| Digestible fat | $2.32 \times .50 = 1.16 \times 20 =$ | 23.2 | pounds. |
| Digestible proteine | $9.19 \times .64 = 5.88 \times 20 =$ | 117.6 | " |
| Digestible carbohydrates | $57.09 \times .68 = 38.82 \times 20 =$ | 776.4 | " |
| Digestible fiber | $31.28 \times .62 = 19.39 \times 20 =$ | 387.8 | " |

The analysis of very good timothy hay is therefore

23.2 pounds of digestible fat per ton,
117.6 " " " proteine per ton,
1,164.2 " " " carbohydrates and fiber per ton.

3. *If the material is of medium or average quality.* In this case a similar calculation may be carried through, in which the data corresponding to the condition of the crop must be used. Since, however, by far the largest number of fodders and feeds fall under this case, this calculation has been made for each of the various feeding-stuffs; the results thus secured have been incorporated in the table upon pages 116 and 117. Therefore, we have only to turn to page 116, where we will see that the analysis of medium timothy hay is

17.6 pounds of digestible fat per ton,
71.2 " " " proteine per ton,
974.0 " " " carbohydrates and fiber per ton.

By precisely the same method as described in these three cases the actual nutriment of each of the feeding-stuffs may be determined according to its quality, with considerable accuracy.

# ANALYTICAL METHODS.

### POTASH.

Lindo's method, as described in the report for 1887, was used the entire season, with perfect satisfaction.

### PHOSPHORIC ACID.

The solution of phosphates was secured by the potassium chlorate and the magnesium nitrate methods. These methods have been on the whole satisfactory, although a few materials are difficult of oxidation; of these, castor pomace is a notable example. The averages of the determinations in over 150 samples are within the limits of experimental error; nitrate of magnesia giving results less than five-hundredths of one per cent. higher than those secured by the chlorate of potash.

### NITROGEN.

1. *Results obtained by Kjeldahl and soda-lime methods.* Kjeldahl's method, as described in detail in previous reports, was used this season without further modification. The total nitrogen in all samples free from nitrates was determined by both methods.

Of 134 samples of complete fertilizers, 18 samples of high-grade nitrogenous material, and 19 samples of ground bone, the average results in total nitrogen are practically identical by both methods.

2. *A comparison of methods for the determination of all forms of nitrogen contained in fertilizers.* The modification of Kjeldahl's method, and the absolute method, as described in the report for 1887, were used in all samples of complete fertilizers containing nitrates that were analyzed by the Station during the past season. The average determinations of 42 samples show that the percentages of nitrogen

secured were almost identical; the average difference by the two methods being less than two-hundredths of one per cent.

Blank determinations are always made, and the results are modified by the amount of the constant error due to re-agents, &c.

## A COMPARISON OF METHODS FOR THE DETERMINATION OF ALL FORMS OF NITROGEN CONTAINED IN FERTILIZERS.

| Station Number. | Percentage of Nitrogen—Kjeldahl modified by Scovell. | Percentage of Nitrogen—Absolute Method. | Station Number. | Percentage of Nitrogen—Kjeldahl modified by Scovell. | Percentage of Nitrogen—Absolute Method. | Station Number. | Percentage of Nitrogen—Kjeldahl modified by Scovell. | Percentage of Nitrogen—Absolute Method. | Station Number. | Percentage of Nitrogen—Kjeldahl modified by Scovell. | Percentage of Nitrogen—Absolute Method. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2157 | 2.68 | 2.73 | 2378 | 3.14 | 3.26 | 2450 | 2.25 | 2.28 | 2608 | 2.05 | 2.17 |
| 2164 | 3.21 | 3.25 | 2380 | 4.05 | 4.18 | 2469 | 4.27 | 4.34 | 2618 | 4.02 | 3.98 |
| 2171 | 2.67 | 2.51 | 2384 | 4.17 | 4.27 | 2472 | 2.72 | 2.73 | 2623 | 2.63 | 2.62 |
| 2276 | 3.67 | 3.81 | 2385 | 3.93 | 4.05 | 2504 | 5.31 | 5.41 | 2625 | 2.02 | 2.12 |
| 2283 | 2.24 | 2.31 | 2418 | 7.33 | 7.40 | 2514 | 4.13 | 4.05 | 2638 | 4.92 | 5.07 |
| 2284 | 2.40 | 2.37 | 2425 | 3.68 | 3.70 | 2532 | 1.69 | 1.59 | 2650 | 2.40 | 2.37 |
| 2298 | 4.54 | 4.56 | 2436 | 3.78 | 3.80 | 2535 | 3.75 | 3.66 | 2669 | 0.92 | 0.96 |
| 2316 | 2.14 | 2.02 | 2440 | 3.56 | 3.51 | 2538 | 2.72 | 2.76 | 2673 | 3.55 | 3.52 |
| 2329 | 3.76 | 3.81 | 2445 | 1.71 | 1.68 | 2561 | 3.30 | 3.31 | 2675 | 2.52 | 2.58 |
| 2348 | 3.10 | 2.99 | 2447 | 3.78 | 3.78 | 2583 | 0.92 | 0.86 | | | |
| 2361 | 2.76 | 2.67 | 2448 | 2.88 | 2.90 | 2601 | 0.79 | 0.67 | | | |

# SORGHUM AND SUGAR-MAKING.

## INVESTIGATIONS UPON THE COST AND VALUE OF SORGHUM SUGAR IN ITS PRODUCTION ON THE FARM AND IN THE SUGAR-HOUSE.

The Legislature of 1881 requested the State Agricultural College to experiment on the sorghum plant, in order to further its cultivation by the farmers of this State. The sorghum was grown on the College Farm, and the chemical work was carried out in the laboratory of the Experiment Station. In the experiments the growth of the cane was satisfactory; the effects of different fertilizers were plainly marked, and the product of sugar carefully ascertained. The same year a law was passed authorizing a bounty of $1.00 per ton to be paid for sorghum cane grown and used in making sugar, and one cent per pound for all the sugar made from sorghum grown in the State; said law to be continued in force for five years.

Trial crops of sorghum were grown upon the College Farm, and tested in the Experiment Station laboratory, from year to year, up to 1886–7, and the demonstration was complete that it could be successfully grown, and that it contained sugar in workable quantities; and the detailed results were given in the annual reports of the Station.

The bounties offered by the State for the production of sorghum-cane and sugar encouraged the Rio Grande Sugar Company, located at Rio Grande, Cape May county, to invest large sums in the erection of a sugar-house, and in the purchase of land upon which to grow sorghum. This enterprise was continued through the years 1881, 1882, 1883, 1884 and 1885. Good crops of cane were grown, and a large amount of sugar was made. Many difficulties were met with in organizing a new industry, but these were fairly overcome. The ruinously low prices of sugar in the latter years, however, took away all chances of profit in a mill which, at the best, could express only half the sugar in the cane. The process of diffusion, or soaking out the sugar by water, was tried upon a large scale, but difficulties incident to a new business delayed the realization of the hopes of the company, and work by the Rio Grande Sugar Company ended with

1886. The bounties offered by the State ended with 1885. The whole amount of bounties paid to encourage this industry was $43,723.

Mr. Henry A. Hughes, of Cape May City, who had been the superintendent of the works from the beginning, and who was largely interested in overcoming the difficulties experienced in the above enterprise, at the beginning of 1887 organized the Hughes Sugar Company, and with the assistance of the United States Department of Agriculture, built and equipped a small sugar-house, to work 15 or 20 tons of cane per day. The machinery in this house was mainly of his own invention, and included machines for topping, stripping and shredding the cane, and for extracting the sugar by diffusion. The results of the work in 1887 were, in many respects, satisfactory, and the experience gained showed where and how many savings of time, labor and expense could be made.

The Station has, every year, from 1884, had its chemist, Dr. Neale, devote a considerable part of his time to the study of the methods pursued in the sugar-house at Rio Grande, and he has been able to render essential and important aid in arranging and balancing the new inventions. At the beginning of 1888, numerous changes were planned so as to produce effective work, and a large sum of money was appropriated by the Station, to carry them into operation. But these plans for the expenditure of the money were not carried through, and while the time and attention of Dr. Neale have been as fully given to the sugar manufacture, as in any former year, and while the results detailed in the following report are, in some directions, very satisfactory, they are, in others, left to be carried out at some future time.

Better results than ever before have been obtained in extracting the sugar by the smallest quantity of water, and thus saving time and expense in evaporating the diffusion juice, and the studies for economizing labor have shown where other savings can be made. The separating of seeds and leaves from the cane, has removed the causes for the discoloration and peculiar taste of the sugar and molasses, so that they are now undistinguishable from the best of those articles made from sugar-cane.

The growing of sorghum and the manufacture of sugar from it by farmers everywhere in our country, at paying prices, appear to be assured. It is now ready for them to proceed in acquiring, by practice, the skill and experience which is to make it one of the great industries of the nation.

GEO. H. COOK, Director.

New Brunswick, N. J., December 31st, 1888.

# THE SORGHUM SUGAR INDUSTRY.

## A REPORT UPON EXPERIMENTS MADE AT RIO GRANDE DURING THE SEASON OF 1888.

The eighth annual report of this Station contains a detailed description of the Hughes Sugar-House, a brief account of its machinery and a copy of its record for the season of 1887. This record strengthened the opinion that a sorghum sugar industry could be developed in New Jersey, and led to a closer study of the conditions upon which financial success seemed to be dependent. Prominent among these conditions were the questions as to the average percentage of sugar in sorghum, the area of land available for this crop, and the size, the equipment and the management of the sugar-house.

During the months of September and October, 1887, samples of shredded cane were drawn daily, to represent the sorghum which was used during this period in the Rio Grande factory. The results of more than sixty analyses indicated that each ton of unstripped and untopped cane contained on the average one hundred and fifteen pounds of pure sugar.

Within a radius of one mile from a sugar-house properly located in any good farming section of southern New Jersey, two hundred acres of land suitable for sorghum can be found, year after year, without disturbing the present system of crop rotation. Such an area should yield two thousand eight hundred tons of field cane—averaging, as above stated, one hundred and fifteen pounds of pure sugar per ton.

The size of a factory should depend upon the length of the sugar-making season and upon the tonnage of available cane. At Rio Grande, seventy working days can be secured each fall; in order to handle twenty-eight hundred tons of field cane, therefore, the capacity of a house must be at least forty tons per day.

Every machine needed in order to extract ninety per cent. of the total sugar in normal cane, has already been invented and thoroughly

tested. Financial success requires, however, that each machine shall be economic in its demands upon human labor and steam power; that it shall be constructed in such a manner that no repairs shall be necessary during the working season; that, as regards capacity, it shall neither exceed nor fall short of the amount which the plans for the house require; and that the different pieces of apparatus shall be so arranged with reference to each other that mechanical wastes of sugar shall be absolutely impossible. The equipment and arrangement of a sugar-house which can fulfill all of the above conditions is a problem which must be solved before the farmers of this State should turn their attention towards this industry.

The inducement to solve this problem can be stated as follows: A ton of field cane contains, under normal conditions, approximately, one hundred and fifteen pounds of pure sugar, of which 90 per cent., or one hundred and four pounds, can be extracted by means of the diffusion process. Of the total sugar in the melada, at least seventy per cent. will crystallize when the purity of the cane juice is 64°. The yield from each ton of field sorghum should therefore be seventy-two pounds of pure sugar, or eighty-three pounds of raw sugar testing 86 per cent. The balance of the extracted sugar, viz., thirty-two pounds, will remain in the molasses, of which there should be, approximately, *eleven gallons.* Raw sugar testing 86 per cent. was sold in Philadelphia, December 17th, 1888, for five and seven-eighths cents per pound, and raw molasses of the sorghum grade was sold for twenty-three cents per gallon. *The present market value of the possible products from one ton of field sorghum amounts, therefore, to eight dollars; this includes sixty cents' worth of seed.*

The contracts between the farmers and the Sugar-House Company required that all merchantable products secured from the cane should be shared equally. Four dollars, therefore, would represent the cash value to the farm of a ton of cane, which should cost approximately two dollars and fifty cents when delivered at the sugar-mill. This means twenty-one dollars profit per acre, or 30 per cent. interest upon seventy dollars invested in farming-land.

A forty-ton sugar-house can be planned to work field sorghum for approximately two dollars and sixty cents per ton: with four dollars per ton as the company's share of the products a balance would remain of one dollar and forty cents per ton, or fifty-six dollars per day. Seventy days' work under such conditions would leave *thirty-*

*nine hundred dollars* in the treasury at the close of the season. The capital necessary to build and equip a house of the above size is estimated roughly at $15,000.

It is certainly desirable that every effort should be made to improve the quality of sorghum; but it is evident that the vital problems to-day are:

*1. To limit the waste of sugar, in sugar-house manipulations, to ten per cent. of the total amount present in normal cane.*

*2. To limit sugar-house expenses to two dollars and sixty cents per ton of field cane.*

These problems were selected for study during the season of 1888. They involve radical changes in the capacity of nearly every machine in the Rio Grande Sugar-House, and called for new boilers of the Babcock or some other economical pattern.

The spring was spent in fruitless efforts to secure capital; but in May a plan was suggested which promised to provide means for purchasing the diffusion battery and the open evaporator, and for making a number of inexpensive improvements. Money for the purchase of new boilers could not be obtained, and, as a substitute, it was decided that coal-oil burners must be used in concentrating diffusion juices in an open evaporator. This, with one or two minor economies in the use of steam, encouraged Mr. Hughes to attempt a second season.

Attention was then directed towards the cane crop. Corn had already been planted, and experienced men urged that it was too late in the season to plant sorghum. Forty-four acres were, however, pledged to the sugar-house by nearly as many different farmers, and sorghum seed was at once distributed among them. Mr. Hughes leased approximately twenty acres of land in the name of the Agricultural Experiment Station, and succeeded in planting this tract on the 20th of May. Money for the payment of the rent and of the fertilizer bills was furnished by the Station. The farming and harvesting expenses were paid by the sugar company, who also had the whole crop.

The contract between the Agricultural College Experiment Station and the Hughes Sugar-House Company, by which money was to be supplied to the latter for the proposed improvements, was not executed.

Financial aid was then sought and secured from Commissioner

Colman, of the United States Department of Agriculture; but the funds from this source were not available before July 1st, and it was then thought to be inadvisable either to construct a larger diffusion battery or to improve the apparatus for shredding cane. A new evaporator, with the necessary shelter, was, however, provided, and an eleventh cell was added to the small diffusion battery which had been used during the season of 1887.

The maximum capacity of this battery was estimated at fourteen tons of field cane in twenty-two hours; the minimum pay-roll of the house for twenty-two hours exceeded thirty-three dollars; the outlay for labor on one ton of cane consequently could be calculated at two dollars and thirty-five cents. With a battery properly equipped for its work a forty-ton sugar-house can be operated at an expense for labor of twenty-eight dollars per day, or for seventy cents per ton of cane. It was, therefore, evident before the season began, that the capacity of this diffusion battery excluded all hopes of financial success. After one week's work it was also evident that faults in the construction of this battery not only prevented the extraction of ninety per cent. of the sugar present in the cane, but also caused very serious losses of diffusion juice. The expectation of solving either of the above-mentioned problems, this season, was, therefore, abandoned, and attention was directed:

1. To Recording the Changes and Improvements made in the Hughes Sugar-House and its Machinery during the past year.

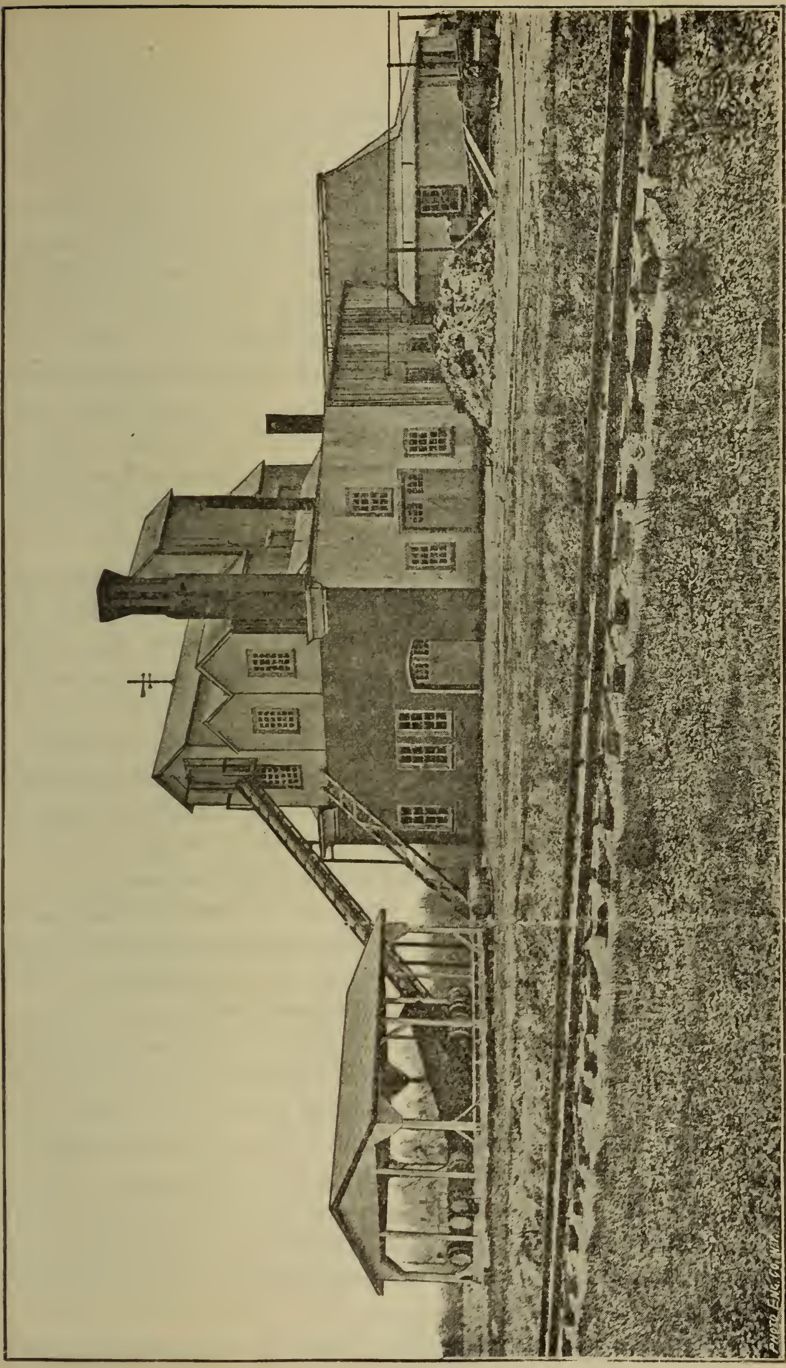
2. To Recording the Chemical Analyses of the Cane, of the Diffusion juice, of the Products from the Open Evaporator, and of the Exhausted Chips or Diffusion Bagasse.

3. To Noting the Tonnage of Cane per Acre, the Farming Expenses, and the Yield and Value of the Sugar Products per ton of Field Cane.

4. To Securing Data for Comparing the Modified Battery in use at Rio Grande with the German Battery in use at Magnolia, Louisiana, and at Fort Scott, Kansas.

5. To Experiments Planned to Determine the Cost of Concentrating Diffusion Juice by the use of Fuel Oil, and the Effect of this Treatment upon the Sugar in said Juice.

6. To Recording all Facts and Opinions which may be of value in Demonstrating that with Present Market Prices and with the Apparatus now in use, Financial Success can be Attained when Normal Sorghum Averages Nine per cent. of Sugar in its Juices.



1.

## THE CHANGES AND IMPROVEMENTS MADE IN THE HUGHES SUGAR-HOUSE AND IN ITS MACHINERY.

This house is located at Rio Grande, Cape May county, within a few feet of the West Jersey railroad. It is described in the last annual report of this Station, as follows: "The main building is thirty-three feet high and thirty feet square. Its walls for the first eighteen feet are built of brick, and above this point the entire structure is sheathed with corrugated iron," etc. The photo-engraving on the preceding page represents it as it appears to-day, and shows that, during the past year, the building has been increased in size by the corrugated iron annex, which serves as a boiler-house and as a shelter for the open evaporator. This annex can be seen on the right of the photograph.

The shed built directly in front of the sugar-house protects the sorghum from the sun or rain. Its dimensions are 20 ft. $\times$ 20 ft. $\times$ 9 ft., and its capacity is approximately twelve tons of field cane. The carrier, which transports the sorghum from this shed to the section cutter, on the highest floor of the sugar-house, is moved at the rate of twenty-one feet per minute. It makes an angle of thirty-five degrees with the ground. This arrangement of shed and carrier was used for the first time in 1888. It reduced the laboring force by two men or boys; it allowed work to progress as usual during heavy rain storms, and in every respect it was regarded as thoroughly satisfactory.

The section cutter, described in detail in the report for 1887, was not modified in any manner. The fans, by means of which the cane sections are separated from the leaves, etc., the shredding-knife and the cells and baskets of the diffusion battery were also used again, without alterations or improvements. A new hydraulic with a plunger ten and one-half inches in diameter was, however, substituted for the smaller one used, in 1887, in elevating and lowering the crane upon which the diffusion baskets hang; this hydraulic was operated by means of a Worthington boiler feed-pump of medium size. As has been already stated, an eleventh cell was added to the battery. The relative position of this cell, and a general idea of the entire apparatus, can be learned from the photo-engraving upon a subsequent page.

In one ton of normal field sorghum there is at least one thousand

two hundred and fifty pounds of juice, of which nearly one thousand and fifty pounds is water; more than ninety-five per cent. of this water must be boiled away before crystallized sugar can be secured in paying quantities. The open evaporator can be used in driving off one-half of this water, but a further concentration of the juice can be gained, without loss of sugar, only with the aid of a vacuum apparatus. Last season the evaporation in the open pan was accomplished with steam; it was found, however, that the boilers were not large enough to generate a sufficient supply, and much lost time was the result. As new boilers could not be purchased this year, coal oil was burned under the evaporator, and direct firing therefore took the place of steam.

This evaporator may be regarded as a boiler-iron box, thirty feet long, four feet wide and twelve inches deep, supported upon walls of masonry, two feet high and twelve inches thick, faced on the inside with fire-brick. The end of this pan directly over the oil burners, is raised slightly, in order to secure a constant movement of the boiling juice towards the outlet at the lower end. The usual arrangements of partial partitions, six inches high, divide the evaporator into forty-five compartments, each eight inches wide and four feet long. The juice is forced by gravity through each of these compartments; its course, therefore, from one end to the other of a pan thirty feet long, causes it to flow in a shallow stream, over one hundred and sixty feet of heated iron, during which it loses one-half of its volume by evaporation. With inlet and outlet valves properly adjusted, and with a constant supply of diffusion juice, the oil burners need little or no attention.

Three of these burners were in position, side by side, under one end of the evaporator; as a rule, one only was in use, rarely two, and never three. The principle on which these burners work can be explained, without entering into a detailed description of their construction; it is enough to state that they are made of a very few feet of ordinary iron pipe, varying in diameter from one-quarter of an inch to two inches. The supply of fuel oil is stored in an elevated tank, at some distance from the building; it flows by gravity, to the burner, through a two-inch pipe, and, in passing through a red-hot iron coil, it is converted into illuminating gas. This gas, mixed with air, is forced by superheated steam through a two-inch tube constructed like a Bunsen burner—an intense heat is developed by its combustion.

A smoke-stack, two feet in diameter, and nearly twenty-five feet

high, is built into the masonry upon which the lower end of the evaporator rests. It draws the flame of burning gas along the bottom of the pan, thereby distributing the heat uniformly, and also removing the risks of explosion, which might follow in a confined space. The evaporator has its place in the annex to the sugar-house; one end of it is within a few feet of the door to be seen on the extreme right of the photograph; the smoke-stack connected with its lower end can be seen rising from the rear of the building. The peculiar form of the roof over the pan, allows the steam from the boiling juice to escape freely, regardless of the direction of the wind. A full discussion of the expense of operating this apparatus, and a record of the amount and kind of work accomplished by it, will be found in a subsequent chapter.

Last season an attempt was made to filter the diffusion juice through sand. The results were unsatisfactory, partly because the apparatus used was hastily and imperfectly constructed, and partly because it was not always properly cleaned and arranged by the boy in charge. Saw-dust was substituted for sand in 1888, and a man was detailed to keep the filters in order. The general appearance, the color and the flavor, both of the sugar and molasses, were noticeably improved by this treatment.

## 2.

### RECORD OF THE ANALYSES MADE AT RIO GRANDE DURING THE SEASON OF 1888.

In addition to studying the construction, the arrangement and the management of the machinery, the chemist of this Station attempted to determine, at least once each day, the percentage of sugar in the sorghum, as well as the percentage of sugar in the products, from each piece of apparatus used in this house. Breaks occur in this record whenever it was necessary for him either to return for a day to New Brunswick, or to devote his entire attention to some one point of special interest.

The house was not opened for work until the 26th of September, and a few of the samples of cane analyzed about the 20th of that month, were taken from the crop standing in the fields. Such samples were stripped and topped by hand. All of the other samples were drawn from cane which was cleaned by machinery. They represent, in each case, approximately, one thousand pounds of well-mixed shreds.

The varieties of sorghum planted were: Early Amber on field Number 1, Late Orange on that portion of field Number 12 which was worked after the 23d of October, White African on a portion of field Number 2, harvested on the 27th inst., and Kansas Orange in all other cases.

The exhausted chips were sampled as fast as they were removed from the battery; a roughly-measured quantity being taken in each case from each one of ten baskets. These portions were subsequently mixed, subsampled and milled in the usual manner.

With a few exceptions, the samples of diffusion juice were, in all cases, drawn from a tank holding three hundred gallons. The samples of the evaporator product were also drawn from a similar tank. The record in detail is shown on the following page.

The averages drawn in this table prove that the cane crop in 1888, relative to that of 1887, was poorer in sugar by 0.75 per cent., and lower in purity by 5.6 degrees. The farmers' explanations for this are, first, late planting; second, early frosts. In some cases the seed were dropped after June 1st, and in all cases the leaves were killed by the frosts which occurred this year on the 4th of October, or ten days earlier than usual. Late Orange sorghum, in particular, seems to have suffered by these conditions, for while the cane was very large and apparently well developed, its juice averaged less than 6.5 per cent. of sugar. Its seed crop was practically worthless, for a very small proportion of tops had matured. In 1887 this variety was well developed when the first frost killed the cane leaves. Its juice then contained, approximately, ten per cent. of sugar.

A comparison of the analyses credited to the cane and to the diffusion juices leads to the following calculations: One hundred pounds of solid matter, *i. e.* sugar, &c., existed on the average in seven hundred and fifteen pounds of cane juice, or in nine hundred and twenty pounds of diffusion juice; that is, cane juice was diluted 28.6 per cent. by the diffusion process. If a similar calculation is made from the records for the season of 1887, the dilution will be fixed at 25.4 per cent. The decreased purity of the diffusion juice was, each year, identical; it amounted to 2.1 degrees.

The exhausted chips or diffusion bagasse, which represented one ton of field sorghum, contained on the average, in 1887, forty and three-tenths pounds of sugar, or thirty-five per cent. of the total amount present in the cane. In 1888 the losses of sugar in exhausted chips

## TABLE No. 1.

| Number of Field. | 1888. | FRESH CHIPS. Brix Corrected. | FRESH CHIPS. Per Cent. of Sugar. | FRESH CHIPS. Purity. | DIFFUSION JUICE. Brix Corrected. | DIFFUSION JUICE. Per Cent. of Sugar. | DIFFUSION JUICE. Purity. | EVAP. PRODUCT. Brix Corrected. | EVAP. PRODUCT. Per Cent. of Sugar. | EVAP. PRODUCT. Purity. | EXHAUSTED CHIPS. Brix Corrected. | EXHAUSTED CHIPS. Per Cent. of Sugar. | EXHAUSTED CHIPS. Purity. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Sept. 20 | 12.96 | 6.62 | 51.1 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1 | " 26 | 13.38 | 6.84 | 51.1 | 11.50 | 5.88 | 51.1 | 29.20 | 15.13 | 51.8 | ........ | ........ | ........ |
| 1 | " 27 | 13.70 | 7.35 | 53.6 | 11.61 | 6.02 | 51.9 | ........ | ........ | ........ | 2.27 | 1.18 | 52.0 |
| 2 | " 21 | 18.55 | 12.53 | 67.5 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 2 | " 27 | 17.81 | 12.30 | 69.0 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 2 | " 28 | 15.40 | 9.58 | 62.2 | 12.15 | 7.23 | 59.5 | 29.60 | 17.78 | 60.1 | 2.56 | 1.50 | 60.1 |
| 2 | " 28 | ........ | ........ | ........ | 11.95 | 7.23 | 60.5 | ........ | ........ | ........ | ........ | ........ | ........ |
| 2 | Oct. 2 | 16.00 | 9.56 | 59.4 | 12.37 | 7.19 | 58.1 | 23.45 | 13.75 | 58.6 | ........ | ........ | ........ |
| 2 | " 2 | ........ | ........ | ........ | 11.69 | 7.01 | 59.8 | ........ | ........ | ........ | ........ | ........ | ........ |
| 3 | Sept. 22 | 14.75 | 8.92 | 60 5 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 3 | Oct. 2 | 14.10 | 8.38 | 59.1 | 10.60 | 5.98 | 56.4 | 25.88 | 15.01 | 58.0 | 2.09 | 1.21 | 57.9 |
| 3 | " 3 | 14.00 | 8.62 | 61.6 | 10.00 | 5.70 | 57.0 | 20.04 | 11.20 | 55.8 | 2.21 | 1.38 | 62.1 |
| 3 | " 3 | 13.43 | 7.90 | 58.8 | 10.90 | 5.99 | 55.0 | 20.00 | 11.06 | 55.3 | 2.70 | 1.56 | 57.7 |
| 4 | " 4 | 14.03 | 7.89 | 56.1 | 11.21 | 6.48 | 57.8 | 28.28 | 15.60 | 55.1 | 3.40 | 1.66 | 48.8 |
| 5 | " 4 | 15.37 | 8.72 | 56.7 | ........ | ........ | ........ | 24.85 | 13.58 | 54.7 | ........ | ........ | ........ |
| 5 | " 4 | 15.57 | 9.06 | 58.8 | 12.30 | 7 45 | 60.5 | ........ | ........ | ........ | 3 56 | 2.07 | 58.1 |
| 6 | " 8 | 14.46 | 8.66 | 59.8 | 11.25 | 6.58 | 58.6 | 26.80 | 15.24 | 57.0 | 2.60 | 1.29 | 49.6 |
| 6 | " 8 | 14.46 | 8.37 | 57.8 | 10.60 | 6.10 | 58.5 | 22.40 | 13.09 | 58.4 | ........ | ........ | ........ |
| 6 | " 8 | ........ | ........ | ........ | ........ | ........ | ........ | 22.66 | 13.13 | 57.9 | ........ | ........ | ........ |
| 7 | " 8 | 14.79 | 9.19 | 62.1 | 9.92 | 5.96 | 60.1 | 20.44 | 11.52 | 56.4 | 3.60 | 1.96 | 54.4 |
| 8 | " 10 | ........ | ........ | ........ | ........ | ........ | ........ | 22.87 | 12.35 | 54.9 | ........ | ........ | ........ |
| 8 | " 10 | ........ | ........ | ........ | ........ | ........ | ........ | 22.66 | 12.36 | 54 6 | ........ | ........ | ........ |
| 8 | " 10 | 14.70 | 8.10 | 55.1 | 11.82 | 6.61 | 55.9 | 20.51 | 11.13 | 54.3 | 3.82 | 1.96 | 51.6 |
| 9 | " 11 | 12.64 | 7.48 | 59.1 | 9.58 | 5.61 | 58.5 | 22.43 | 12.33 | 55.0 | ........ | ........ | ........ |
| 9 | " 12 | 12.80 | 7.91 | 61.8 | ........ | ........ | ........ | 22.26 | 12 30 | 55.2 | 2.80 | 1.71 | 61.0 |
| 10 | " 12 | 13.40 | 8.50 | 63.4 | 9.80 | 5.96 | 60.8 | 22.78 | 12.93 | 56.8 | 2.20 | 1.22 | 55.0 |
| 11 | " 18 | 14.00 | 8.37 | 59.8 | 8.90 | 5.23 | 58.7 | 25.06 | 13.65 | 54.5 | 2.11 | 1.24 | 58.7 |
| 11 | " 18 | 13.50 | 8.25 | 61.1 | 10.30 | 6.15 | 59.7 | ........ | ........ | ........ | 2.00 | 1.14 | 57.0 |
| 12 | " 16 | 12.85 | 7.48 | 58.4 | 9.88 | 5.51 | 55.7 | 22.69 | 12.60 | 55.5 | 2.56 | 1.39 | 54.3 |
| 12 | " 17 | 13 06 | 7.91 | 60.6 | 8.80 | 5.03 | 57.2 | 24.18 | 12.76 | 52.8 | 1.97 | 1 05 | 53.3 |
| 12 | " 22 | 12.43 | 7.69 | 61.9 | 11.90 | 5.95 | 57.7 | ........ | ........ | ........ | 1.54 | 0.92 | 60.0 |
| 12 | " 23 | 12.69 | 7.23 | 57.0 | 10.21 | 5.65 | 55.3 | ........ | ........ | ........ | 2.16 | 1.20 | 55.6 |
| 12 | " 24 | 11.42 | 5.78 | 50.6 | 10 27 | 5.06 | 49.2 | ........ | ........ | ........ | 2.56 | 1.20 | 46.5 |
| 12 | " 25 | 12 67 | 6.94 | 54.8 | 12.32 | 6.70 | 54.4 | ........ | ........ | ........ | 3.49 | 1.58 | 45.2 |
| 12 | " 26 | 12.76 | 6.63 | 52.0 | 11.96 | 6.21 | 51.9 | ........ | ........ | ........ | 2.77 | 0.91 | 32.8 |
| 12 | " 27 | 12.36 | 6.54 | 52.9 | 11.83 | 6.02 | 50.9 | ........ | ........ | ........ | 1.96 | 0.82 | 41.8 |
| 12 | " 29 | ........ | ........ | ........ | 8.88 | 4 68 | 52.7 | 17.77 | 9.58 | 53.8 | ........ | ........ | ........ |
| 12 | " 30 | ........ | ........ | ........ | 10.61 | 5.59 | 52.7 | 24.80 | 12.49 | 50.3 | ........ | ........ | ........ |
| Averages, 1888 | | 13.99 | 8.23 | 58.5 | 10.87 | 6.10 | 56.4 | 23.55 | 13.06 | 55.5 | 2.58 | 1.37 | 53.3 |
| *Averages, 1887 | | 14.02 | 8.98 | 64.1 | 11.18 | 6.93 | 62.0 | 32.40 | 18.68 | 57.7 | 4.03 | 2.46 | 61.0 |

*See Bulletin 18, p. 20, United States Department of Agriculture.

amounted to twenty-two and four-tenths pounds, or twenty-one per cent. of the total amount present in the average cane for that year.

In 1887 the diffusion juice was concentrated in an open evaporator with the aid of steam; it was reduced by this treatment to a fraction more than one-third of its original volume, at an expense of 4.3 degrees of purity, which was probably due to inversion of its sugar by heat. In 1888 the flame from burning fuel oil came in contact with the bottom of the evaporator; the diffusion juice passed in an unbroken stream over this heated surface, and was thereby reduced to less than one-half of its original volume. Its purity was decreased on the average by less than one degree.

The following will serve as a summary: In 1887, 65 per cent., in 1888, 79 per cent. of the total sugar in the cane was extracted. In this respect, therefore, the improvement has been very great. The diffusion process, in 1887, diluted cane juice by 25.4 per cent.; in 1888 this dilution amounted to 28.6 per cent.

The purity of the cane juice was influenced each year in the same manner and to the same extent, viz., decreased by 2.1 degrees. The concentration of the diffusion juice was accomplished in 1888, with considerably less than the usual losses by inversion.

## 3.

## THE TONNAGE OF CANE PER ACRE, THE FARMING EXPENSES, AND THE YIELD AND VALUE OF SUGAR PRODUCTS PER TON OF FIELD CANE.

It has been stated that forty-four acres of sorghum were pledged to the sugar-house by farmers. Much of this acreage, however, was not planted, because of the feeling which prevailed in May, that the sugar-house would probably remain closed in the fall. White African seed failed to germinate on one relatively large plot, and the crops on several acres were not worth the trouble and expense of harvesting; in fact, very few fields bore any resemblance to the last year's crops.

As a rule, farming expenses were not recorded, and the exact areas of land planted could not be reported with certainty. An exception to the above statement is furnished by Mr. E. Hildreth and by Mr. Hughes. The former planted a trifle more than an acre, and the latter harvested the cane from 18.5 acres.

Mr. Hildreth's record is as follows:

10

Area planted.......................................... 1.11 acres.
Yield of field cane.......................................... 11.3 tons per acre.
Date of planting, June 1st; variety of cane, Kansas Orange.

| | |
|---|---|
| Expense for manure, @ $1.00 per load | $7 00 |
| Plowing | 1 50 |
| Planting | 75 |
| Thinning, cultivating and hoeing | 3 00 |
| Cutting and hauling | 8 00 |
| Rent of land | 6 00 |
| Total cost per plot | $26 25 |
| Total cost per acre | 23 60 |
| Total cost per ton of cane | 2 09 |
| Yield of sugar per ton (test, 85 per cent.), 69.5 lbs. @ 5⅞c | $4 18 |
| Yield of molasses per ton, 11.4 gals. @ 23c | 2 62 |
| Total value of sugar and molasses per ton of cane | $6 80 |
| Assumed value of the seed per ton of cane | 60 |
| Total value of all merchantable products per ton of cane | $7 40 |
| Cash value of Mr. Hildreth's share | $3 70 |

The net profits to Mr. Hildreth amounted to $1.61 per ton of cane, or $18.19 per acre.

This is by far the best record of the year. The men in charge of the battery had profited by three weeks' experience, wastes were reduced to a minimum, and the cane juice, though containing only 8.3 per cent. of sugar, was, in regard to purity, above the average for the season. Eighty-three per cent. of the total sugar present in the crop was extracted, and more than eighty per cent. of the total amount was found in the melada. The losses of extracted sugar amounted to 2.75 per cent. of the total sugar in the cane. This loss includes sugar which had been inverted and which remains in the molasses and aids in making it a merchantable product.

Mr. Hughes' fields were accurately surveyed after three-fourths of the cane had been harvested. The areas were as follows:

| | Yield of tons per acre. |
|---|---|
| Nichol Tract—1.85 acres: Early Amber cane | 10.2 |
| Smith Tract—3.58 acres: Kansas Orange and White African | 9.7 |
| Cresse Tract—6 87 acres: Kansas Orange | 7.5 |
| Cresse Tract—6.23 acres: Late Orange | 7.1 |

Cane planted May 19th, 1888.

EXPENSE ACCOUNT.

| | | |
|---|---|---|
| The labor account for above area | | $134 72 |
| Fertilizer, viz., 1 ton Dissolved Bone | $30 00 | |
| 3,163 lbs. Muriate of Potash | 63 26 | |
| | | 93 26 |
| The rent of land | | 108 94 |
| Harvesting expenses, @ 50c. per ton, 149.4 tons | | 74 70 |
| Total expense for 18.5 acres | | $411 62 |
| Total expense per acre | | 22 25 |
| Total expense per ton of cane | | 2 75 |

The Nichol field has been planted with sorghum every season since 1880. Last year its crop averaged nearly twenty tons per acre; this year it yielded only 10.2 tons. This cane was also of very inferior quality; its juice contained less than 6.75 per cent. of sugar, with a purity of 51 degrees only. No sugar crystals would form in the melada, and the entire product consequently was put into the syrup tank. The yield was sixteen gallons per ton of cane, worth twenty-three cents per gallon, making $3.68 per ton as the total value for the sugar-house products. The seed yields are not known, but probably did not exceed a cash value of sixty cents per ton. The farmer's share of all products on this valuation would amount to $2.12 only, per ton of cane, leaving a loss of sixty-two cents per ton, or $6.20 per acre.

In the case of the Late Orange sorghum, the results are even more discouraging. Its leaves were killed by the frost of October 4th, and on that date the deterioration of this immature cane seems to have begun. The average per cent. of sugar in its juice was six and one-half only; the purity of its juice was approximately 52.5°. Crystals formed in its melada, but in such small amounts that the attempt to separate them from the syrup was abandoned. The melada secured from 6.23 acres, when diluted to 72° Brix, will yield six hundred and fifty gallons of syrup, worth, in round numbers, $150, an amount barely sufficient to pay farming expenses, leaving the sugar-house work a total loss.

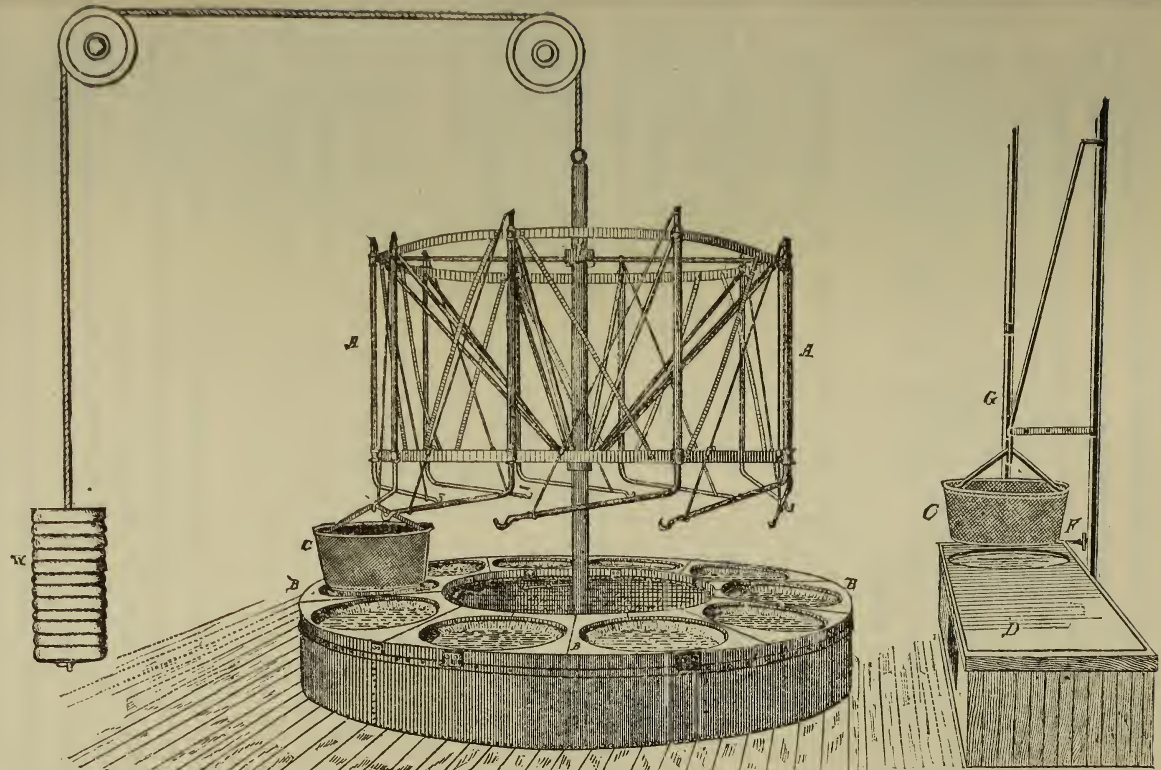
This field seems to have been entirely unfit for sorghum; a very considerable portion of it produced no cane whatever, being, as far as the eye can judge, little better than drift sand, upon which beach-burrs only appear to thrive. It was leased for this work because it was the only available tract within hauling distance from the sugar-house, all

first-class ground in the neighborhood having been planted before plans for a sorghum crop had been prepared.

The variety of Late Orange cane occupied less than one-half of this field, 6.87 acres having been planted with the Kansas Orange seed. The yield was 51.2 tons of field cane, testing 8.3 per cent. of sugar in its juice; purity, 59.8. Forty pounds of raw sugar and eight and one-tenth gallons of raw molasses were secured per ton of field cane. Including sixty cents' worth of seed, the above products have a market value of $4.81 only, one-half of which must be credited to the sugar-house account. This leaves $2.40 per ton with which to pay farming expenses aggregating $2.75. The deficit on this account is consequently thirty-five cents per ton of field cane.

The Smith tract of 3.58 acres has now produced eight consecutive crops of sorghum. In 1887, fourteen acres of this land averaged fifteen tons of field cane per acre. In 1888, the average yield was nine and seven-tenths tons. The purity of the juice from this cane was nearly sixty-one degrees; its sugar test was 9.57 per cent. Forty-eight pounds of raw sugar and eight and one-tenth gallons of raw molasses were secured per ton. Including sixty cents' worth of seed, these products have a market value of $5.29. On crediting one-half of this amount to the fields, it will be seen that a balance of eleven cents per ton must be charged as a loss on the farming account.

The examination of the exhausted chips or bagasse from the cane grown on the Cresse and Smith fields, proves that more than eighty-two per cent. of the total sugar in this crop was extracted by the diffusion battery. The melada records indicate, however, that fifty-three per cent. only of the total sugar in the fresh cane was secured in merchantable forms; nearly twenty-nine per cent. of the total sugar is, therefore, missing. A relatively small portion of this loss can be charged to invert sugar; the greater portion of it, however, was probably caused by mechanical defects in the construction of the battery, by which diffusion juice was wasted. This opinion is strengthened by the fact that an unexplained loss of sugar, varying from 18.5 per cent. to 30 per cent. of the total amount present in the cane, is charged against the crop from every field for which complete records exist. The only exception to this rule is furnished by the Hildreth crop. In this case special care was taken to avoid losses from this source, and in this case, as above mentioned, the deficit amounted to 2.75 per cent. only.



Diffusion Battery

## 4.

### EXPERIMENTS MADE TO SECURE DATA FOR COMPARING THE MODIFIED DIFFUSION BATTERY IN USE AT RIO GRANDE, WITH THE GERMAN DIFFUSION BATTERY USED IN MAGNOLIA, LOUISIANA, AND IN FORT SCOTT, KANSAS.

The photo-engraving on the preceding page represents the modified diffusion battery used in the Hughes Sugar-House, at Rio Grande. Its description, taken in part from the eighth annual report of this Station, is as follows:

This apparatus includes, first, the main battery, second, the eleventh cell. The main battery consists of:

I. Ten copper tanks or cells, marked *B* in the diagram, surrounded by a water-tight boiler-iron steam jacket. Each of these cells is twenty-six inches in diameter at the bottom, thirty inches in diameter at the top, and nine inches deep; when filled to a depth of seven inches, each cell holds twenty gallons of water.

II. Ten or more baskets of perforated copper, one of which, marked *C*, can be seen in the engraving. These baskets are of such shape and size that one can easily be placed within a cell and leave little or no waste room; with thorough packing, each basket holds, approximately, one hundred and five pounds of cane shreds.

III. A crane or derrick, marked *A* in the engraving. This derrick has ten arms, one for each cell in the battery; these arms radiate from the central shaft like spokes in a wheel, and are connected by heavy iron rods, so that their relative positions cannot be disturbed; consequently, the movement of any one of them, in any direction, involves a corresponding motion of the entire system. This derrick can be raised or lowered through a space of eighteen inches, by means of a hydraulic press; it can also be revolved by hand, around its shaft, as fast and as far as the foreman desires.

The copper cells or tanks are arranged in a circle ten feet in diameter. Each tank is provided with a two-inch outlet, and with the steam fittings necessary to heat its contents to 212° Fahr.

The derrick shaft forms the center of this circle. It is a four-inch pipe, approximately twelve feet long; its lower end rests on the plunger of the hydraulic press, and its upper end is chained to a

counterpoise. The engraving shows that the baskets of cane chips are attached to the derrick by means of bent rods, pivoted upon the ends of the arms; this arrangement allows the baskets to be swung outside of the circle of the tanks, for convenience in handling.

The eleventh cell is located outside of the circle of the main battery; in size and shape it is identical with the tanks already described; baskets which are immersed in it, are subsequently transferred to the cells of the main battery. It is provided with a draining board, marked *D*, and with a small crane and hydraulic, marked *F*.

Assume that the apparatus has not been in use; the first step will be to draw twenty gallons of hot water into each cell of the main battery. A covered basket, containing one hundred pounds of cane shreds is then hung upon an arm of the crane, and immediately lowered into cell Number 1. After a delay of one minute, the crane is raised and revolved, so that basket Number 1 hangs over cell Number 2. A second basket is then hung upon the arm over cell Number 1, and the crane is lowered. Whenever it is raised it is also revolved, and an empty arm is thereby brought over cell Number 1. A basket of fresh shreds is always hung upon this arm, and immersed in cell Number 1, when the crane is lowered. This process is repeated until a basket of chips hangs from each of the arms. When this point is reached, the basket on arm Number 1 will have been dipped into ten different cells full of hot water; its contents will have been thoroughly leached, and the exhausted chips can then be emptied upon the bagasse pile.

The contents of cells Numbers 1 and 2 will be relatively strong solutions of sugar; these solutions are allowed to flow and mix in a tank placed under the battery, from which the mixture is afterwards pumped into a second tank, elevated several feet above the eleventh cell. The pipe through which this juice is carried into this cell, is marked *G* in the engraving.

When approximately twenty-two gallons of this juice has been collected in the eleventh cell, two baskets of fresh cane are successively soaked in it, and then transferred in turn to cell Number 3 in the main battery; cells 1 and 2 in the meantime having been filled with hot water in order to finish the leaching process on baskets Numbers 2 and 3. The work of extracting the sugar, begun in this manner, is then carried on without interruption from Monday morning until Saturday night. The juice from the eleventh cell flows directly into the evaporator.

This apparatus was tested on the 23d of November, 1887. The cane was then frozen, and many of the ruling conditions were not under control. A second test was made on the 27th of October, 1888.

The cane used was immature Orange. In passing through the stripping and topping process, it suffered a loss of 22.2 per cent. Contrary to custom, this cane was shredded twice, in order to secure as favorable diffusion as possible. One result of this step was that the shreds were packed much closer than usual in the baskets, which, of necessity, caused an increased concentration of the diffusion juice. The analytical results are as follows:

| | Brix. | Per cent. of Sugar. | Purity. |
|---|---|---|---|
| Fresh cane shreds | 12.36 | 6.54 | 52.9° |
| Diffusion juice drawn into the eleventh cell, | 11.16 | 5.63 | 50.4° |
| Diffusion juice discharged from the eleventh cell | 11.83 | 6.02 | 50.9° |
| Juice from exhausted chips | 1.96 | 0.82 | 41.8° |
| *Juice from leaf sheath | 4.46 | 1.85 | 41.4° |

Data relating to the weight of cane used in each basket, and to the volume of water or juice in each cell, records of the temperature of the solutions and of the time of immersion and drainage, &c., &c., are given in detail in the table on the following page.

From the data contained in these tables the following conclusions can be drawn:

1. One ton of cleaned cane shreds contained 117.7 lbs. sugar.
2. The bagasse from one ton of cleaned cane shreds contained 17.6 lbs. sugar.
3. *Extraction of sugar*, *85 per cent.*
4. One hundred pounds of solids found in 809 pounds of cane juice.
5. One hundred pounds of solids found in 846 pounds of diffusion juice.
6. *Per cent. of dilution*.......... 4.6
7. Purity of cane juice.......... 52.90°
8. Purity of diffusion juice.......... 50.90°
9. *Loss in purity*.......... 2.00°

A close study of the data given in Table Number 2 shows that the volume of the mixed juices, from the so-called thick and thin cells, discharged at the same time from the main battery, amounts, in several cases, to more than twenty-seven gallons; the eleventh cell, into which this juice must be pumped, can take, on the average, twenty-three gal-

*Sections of leaf sheath were separated from the diffusion bagasse and milled; the purity of the juice aroused a suspicion that most of the sugar, lost in this bagasse, was stored in said sheaths.

## TABLE No. 2.

TRIAL OF THE DIFFUSION BATTERY, MADE OCTOBER 27TH, 1888.

### ELEVENTH CELL RECORD.

| Number of Baskets. | Time of Immersion. | Time of Drainage. | Temperature after First Dip. | Temperature after Second Dip. | Number of Gallons Drawn in. | Number of Gallons Discharged. |
|---|---|---|---|---|---|---|
| | M. | M. | C. | C. | gal. | gal. |
| 1 and 2 | 3 | 1 | 78 | 73 | 24.0 | 20.8 |
| 3 and 4 | 3 | 1 | 75 | 72 | 24 0 | 16.0 |
| 5 and 6 | 3 | 1 | 72 | 70 | 22.4 | 18.1 |
| 7 and 8 | 3 | 1 | 72 | 80 | 22.4 | 16.7 |
| 9 and 10 | 3 | 1 | 75 | 76 | 24.0 | 18.5 |
| 11 and 12 | 3 | 1 | 70 | 80 | 20.1 | 15.7 |
| 13 and 14 | 3 | 1 | 75 | 78 | 22.8 | 18.1 |
| 15 and 16 | 3 | 1 | 73 | 73 | 24.4 | 20.1 |
| 17 and 18 | 3 | 1 | 72 | 70 | 21.6 | 15.3 |
| 19 and 20 | 3 | 1 | 75 | 75 | 23.2 | 21.6 |
| 21 and 22 | 3 | 1 | 72 | 75 | 22.4 | 17.1 |
| 23 and 24 | 3 | 1 | 75 | 70 | 22.4 | 17.4 |
| 25 and 26 | 3 | 1 | 78 | 75 | 22.4 | 16.7 |
| 27 and 28 | 3 | 1 | 68 | 75 | 22.4 | 18.1 |
| 29 and 30 | 3 | 1 | 69 | 74 | 22.4 | 17.7 |

### WEIGHTS OF CANE BEFORE AND AFTER DIFFUSION.

| Number of Basket. | Weight of Baskets Empty. | Weight of Baskets Full of Fresh Chips. | Weight of Baskets Full of Exhausted Chips. | Net Weight of Baskets of Fresh Chips. | Net Weight of Baskets of Exhausted Chips. | Per cent. of Increase. |
|---|---|---|---|---|---|---|
| | lbs. | lbs. | lbs. | lbs. | lbs. | |
| 1 | 52 | 160 | 182 | 108 | 130 | 20.4 |
| 2 | 52 | 160 | 180 | 108 | 128 | 18.5 |
| 3 | 52 | 160 | 176 | 108 | 124 | 14.8 |
| 4 | 52 | 160 | 181 | 108 | 129 | 19.4 |
| 5 | 52 | 160 | 181 | 108 | 129 | 19.4 |
| 6 | 52 | 160 | 182 | 108 | 130 | 20.4 |
| 7 | 52 | 160 | 180 | 108 | 128 | 18.5 |
| 8 | 52 | 160 | 180 | 108 | 128 | 18.5 |
| 9 | 52 | 160 | 180 | 108 | 128 | 18.5 |
| 10 | 52 | 160 | 180 | 108 | 128 | 18.5 |
| 11 | 52 | 160 | 180 | 108 | 128 | 18.5 |
| 12 | 52 | 160 | 175 | 108 | 123 | 13.9 |
| 13 | 52 | 160 | 175 | 108 | 123 | 13.9 |
| 14 | 52 | 160 | 175 | 108 | 123 | 13.9 |
| 15 | 52 | 160 | 178 | 108 | 126 | 16.6 |
| 16 | 52 | 160 | 178 | 108 | 126 | 16.6 |
| 17 | 52 | 160 | 178 | 108 | 126 | 16.6 |
| 18 | 52 | 160 | 180 | 108 | 128 | 18.5 |
| 19 | 52 | 160 | 178 | 108 | 126 | 16.6 |
| 20 | 52 | 160 | 175 | 108 | 123 | 13.9 |
| 21 | 52 | 160 | ......... | 108 | ......... | ......... |
| 22 | 52 | 160 | ......... | 108 | ......... | ......... |
| 23 | 52 | 160 | ......... | 108 | ......... | ......... |
| 24 | 52 | 160 | ......... | 108 | ......... | ......... |
| 25 | 52 | 160 | ......... | 108 | ......... | ......... |
| 26 | 52 | 160 | ......... | 108 | ......... | ......... |
| 27 | 52 | 160 | ......... | 108 | ......... | ......... |
| 28 | 52 | 160 | ......... | 108 | ......... | ......... |
| 29 | 52 | 160 | ......... | 108 | ......... | ......... |
| 30 | 52 | 160 | ......... | 108 | ......... | ......... |
| Av.. | 52 | 160 | 178.9 | 108 | 126.7 | 17.3 |

### MAIN BATTERY RECORD.

| | Crane Lowered. | Crane Raised. | Baskets Immersed. | Baskets Drained. | Gallons of Water in Last Cell. | Gallons Discharged, Thick Cell. | Gallons Discharged, Thin Cell. | Temperature of Thick Cell. | Temperature of Thin Cell. |
|---|---|---|---|---|---|---|---|---|---|
| | A. M. | A. M. | M. | M | gal. | gal. | gal. | C. | C. |
| 1 | 11.175 | 11.19 | 1.5 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 2 | 11.20 | 11.23 | 3.0 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 3 | 11.24 | 11.26 | 2.0 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 4 | 11.27 | 11.285 | 1.5 | 1 | 18.5 | ? | ......... | ...... | ...... |
| 5 | 11.295 | 11.325 | 3.0 | 1 | 18.5 | ......... | 14.6 | ...... | ...... |
| 6 | 11.335 | 11.355 | 2.0 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 7 | 11.365 | 11.38 | 1.5 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 8 | 11.39 | 11.42 | 3.0 | 1 | 18.5 | 10.4 | ......... | ...... | ...... |
| 9 | 11.43 | 11.455 | 2.5 | 1 | 18.5 | ......... | 12.4 | ...... | ...... |
| 10 | 11.465 | 11.48 | 1.5 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 11 | 11.49 | 11.51 | 2.0 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 12 | 11.52 | 11.55 | 3.0 | 1 | 18.5 | 11.8 | ......... | ...... | ...... |
| 13 | 11.56 | 11.585 | 2.5 | 1 | 18.5 | ......... | 14.3 | ...... | ...... |
| 14 | 11.595 | 12.035 | 4.0 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| | P. M. | P. M. | | | | | | | |
| 15 | 12.045 | 12.07 | 2.5 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 16 | 12.08 | 12.12 | 4.0 | 1 | 18.5 | 13.0 | ......... | 65° | ...... |
| 17 | 12.13 | 12.16 | 3.0 | 1 | 18.5 | ......... | 14.3 | ...... | 70° |
| 18 | 12.17 | 12.19 | 2.0 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 19 | 12.20 | 12.215 | 1.5 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 20 | 12.225 | 12.255 | 3.0 | 1 | 18.5 | 10.3 | ......... | ...... | ...... |
| 21 | 12.265 | 12.285 | 2.0 | 1 | 18.5 | ......... | 10.0 | ...... | ...... |
| 22 | 12.295 | 12.31 | 1.5 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 23 | 12.32 | 12.34 | 2.0 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 24 | 12.35 | 12.38 | 3.0 | 1 | 18.5 | 12.8 | ......... | ...... | ...... |
| 25 | 12 39 | 12.415 | 2.5 | 1 | 18.5 | ......... | 14.6 | ...... | ...... |
| 26 | 12.425 | 12.46 | 3.5 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 27 | 12.47 | 12.49 | 2.0 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 28 | 12.50 | 12.53 | 3.0 | 1 | 18.5 | 13.1 | ......... | 65° | ...... |
| 29 | 12.54 | 12.57 | 3.0 | 1 | 18.5 | ......... | 13.3 | ...... | ...... |
| 30 | 12.58 | 1.00 | 2 0 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 31 | 1.01 | 1.03 | 2.0 | 1 | 18.5 | ......... | ......... | 65° | ...... |
| 32 | 1.04 | 1.07 | 3.0 | 1 | 18.5 | 14.5 | ......... | ...... | 65° |
| 33 | 1.08 | 1.115 | 3.5 | 1 | 18.5 | ......... | 13.1 | ...... | ...... |
| 34 | 1.125 | 1.15 | 2.5 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 35 | 1.16 | 1.18 | 2.0 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 36 | 1.19 | 1.23 | 4.0 | 1 | 18.5 | 10.3 | ......... | ...... | ...... |
| 37 | 1.24 | 1.265 | 2.5 | 1 | 18.5 | ......... | 14.6 | ...... | 65° |
| 38 | 1.275 | 1.295 | 2.0 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 39 | 1.305 | 1.32 | 1.5 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 40 | 1.33 | 1.36 | 3.0 | 1 | 18.5 | 11.6 | ......... | 70° | ...... |
| 41 | 1.37 | 1.39 | 2.0 | 1 | 18.5 | ......... | 15.9 | ...... | 68° |
| 42 | 1.40 | 1.42 | 2.0 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 43 | 1.43 | 1.445 | 1.5 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 44 | 1.455 | 1.465 | 1.0 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 45 | 1.475 | 1.48 | 0.5 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 46 | 1.49 | 1.51 | 2.0 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 47 | 1.52 | 1.535 | 1.5 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 48 | 1.545 | 1.56 | 1.5 | 1 | 18.5 | ......... | ......... | ...... | ...... |
| 49 | 1.57 | 1.59 | 2.0 | 1 | 18.5 | ......... | ......... | ...... | ...... |

lons only; it follows, therefore, that an accumulation of this juice must result, and that at the end of each hour there will be at least one charge of twenty-three gallons which cannot be treated in the eleventh cell, and must be transferred to the evaporator without further concentration. It is also well known that in a battery free from mechanical defects this accumulation will be considerably increased, by preventing the losses of diffusion juice which have characterized this season's work. The data available at present indicate that, when due allowance is made for these conditions, the dilution need not exceed seven and one-half per cent. There is also a strong probability that it can be reduced considerably below this point.

This battery has been subjected to friendly criticism from various sources, the principal objections being:

1. The expense of raising and lowering the crane.
2. The effect, exercised by the air, upon the sugar in the juice.
3. The relatively incomplete extraction of sugar.

The expense of raising and lowering the loaded crane is very much less than an ordinary observer would imagine; it can be calculated roughly as follows:

The crane proper is practically counterpoised; the load which must be raised by steam is the weight of ten baskets full of chips. In a battery with a daily capacity of forty tons of field-cane, each basket should contain two hundred and seventy-five pounds of shreds; including the weight of the ten baskets, the load will approximate four thousand pounds. This must be raised and lowered twenty times per hour, or four hundred and forty times per day of twenty-two hours.

It is not probable that it will be necessary to raise the crane exactly thirty-six inches; for convenience of calculation, however, the height may be fixed at three feet. To raise four thousand pounds three feet high is equivalent to raising twelve thousand pounds one foot high. The management of the battery requires that this shall be done twenty times per hour, consequently the work done is equivalent to raising two hundred and forty thousand pounds one foot high per hour, or four thousand pounds one foot high per minute. As a horse-power is the energy used in lifting thirty-three thousand pounds one foot high per minute, the energy used in operating the loaded crane may be estimated approximately at one-eighth of one-horse power. A horse-

power in large boilers calls for, approximately, two pounds of hard coal per hour; in small plants of from eight to ten-horse, the consumption amounts in practice to, approximately, five and one-half pounds per horse-power per hour; the cost of coal per horse-power per hour ranges, therefore, from one-half of one cent to one and one-quarter cents, when coal costs five dollars per ton. The coal used in operating a crane which requires one-eighth of one horse-power is consequently inappreciable.

In studying the second and third objections to the Hughes apparatus, it has been thought best to compare its work with that of the German battery, which at present is the only other form in use in the sorghum sugar industry. This comparison has been drawn by tabulating the data published by Dr. Wiley, the chemist of the United States Department of Agriculture. This data can be found in Bulletin 18 of the chemical division. It covers the experimental work carried out at Magnolia, Louisiana, under Dr. Wiley's personal supervision, and also the commercial work in the sugar-house at Fort Scott, Kansas, recorded daily by Dr. Crampton, assistant chemist of the United States Department of Agriculture. The Rio Grande records were taken by the chemist of this Station. The tabulation will be found on the next page.

The points for comparison have been printed in black-faced type. They are—

1. The relative purity of the cane and of the diffusion juices.
2. The absolute losses of sugar per ton of cleaned cane.
3. The percentage of extraction.

In the work at Magnolia the average decrease in purity of the diffusion juice was 1.8 degrees. At Fort Scott an increase of 1.2 degrees is noted, and at Rio Grande a decrease in the first case of 1.35 degrees, and in the second of 2.0 degrees. If the air, acting upon the sugar in the cane chips during the process of diffusion in the Rio Grande battery, caused inversion, this inversion could have been no greater than that caused by other agencies upon the sugar in the tropical cane of Louisiana. The increased purity in the diffusion juice at Fort Scott is claimed to be due to the use of carbonate of lime in the battery; this fact excludes this record from the comparison.

The absolute amount of sugar left in the exhausted chips, corresponding to one ton of cleaned cane, could be obtained from the data

## TABLE No. 3.

| | Number of Run. | JUICE—CLEANED CHIPS. Corrected Brix. | JUICE—CLEANED CHIPS. Per Cent. Sucrose. | JUICE—CLEANED CHIPS. Purity. | JUICE—DIFFUSION BATTERY. Corrected Brix. | JUICE—DIFFUSION BATTERY. Per Cent. Sucrose. | JUICE—DIFFUSION BATTERY. Purity. | Purity Diffusion Juice. Increased by— | Purity Diffusion Juice. Diminished by— | 100 LBS. SOLIDS FOUND IN— Pounds of Mill Juice. | 100 LBS. SOLIDS FOUND IN— Pounds of Diffusion Juice. | Diffusion Dilutes Mill Juice by— | Pounds of Juice in Exhausted Chips equal to One Ton of Cleaned Cane. | Per Cent. of Sugar in such Juice, | Pounds of Sugar Lost in Chips from One Ton of Cleaned Cane. | Pounds of Juice per Ton of Cleaned Cane. | Per Cent. of Sugar in Juice. | Pounds of Sugar per Ton of Chips. | Per Cent. of Extraction. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 15.03 | 12.26 | 81.57 | 10.64 | 8.76 | 82.30 | 0.80° | ........... | 665 | 940 | p. c. 41.2 | 2,160 | 0.73 | 15.8 | 1,800 | 12.26 | 221 | 92.9 |
| | 2 | 14.98 | 12.61 | 84.10 | 9.66 | 7.96 | 82.40 | ........... | 1.70° | 667 | 1,035 | 55.0 | 2,160 | 0.89 | 19.2 | 1,800 | 12.61 | 227 | 91.6 |
| | 3 | 13.88 | 11.53 | 83.06 | 9.46 | 7.85 | 82.98 | ........... | 0.08° | 720 | 1,057 | 46.8 | 2,160 | 0.75 | 16.2 | 1,800 | 11.53 | 208 | 92.2 |
| | 4 | 16.79 | 14.60 | 86.95 | 10.78 | 9.50 | 88.10 | 1.20° | ........... | 596 | 927 | 55.5 | 2,160 | 0.91 | 19.6 | 1,800 | 14.60 | 263 | 92.6 |
| | 5 | 16.66 | 13.98 | 83.91 | 10.48 | 8.41 | 80.24 | ........... | 3.67° | 600 | 954 | 59.0 | 2,160 | 0.44 | 9.5 | 1,800 | 13.98 | 252 | 96.2 |
| Average Results............... | ...... | 16.19 | 13.71 | 84.70 | 10.39 | 8.62 | 82.90 | ........... | 1.80° | 617 | 962 | 51.5 | 2,160 | 0.63 | 13.6 | 1,800 | 13.71 | 247 | 94.5 |
| | | 16.14 | 9.54 | 59.10 | 11.08 | 6.68 | 60.30 | 1.20° | ........... | 619 | 903 | 45.9 | 2,160 | 0.69 | 14.9 | 1,800 | 9.54 | 171.7 | 91.33 |
| | | 15.27 | 9.12 | 59.76 | 13.78 | 8.00 | 58.43 | ........... | 1.35° | 655 | 725 | 10.7 | 2,160 | ......... | 16.8 | 1,800 | 9.12 | 164.0 | 89.8 |
| | | 12.36 | 6.54 | 52.90 | 11.83 | 6.02 | 50.90 | ........... | 2.00° | 809 | 846 | 4.6 | 2,160 | 0.82 | 17.6 | 1,800 | 6.54 | 117.7 | 85.0 |

given in Bulletin 18, only by learning the weight of these chips when they were removed from the battery. Accurate records at Rio Grande shew that one hundred pounds of cleaned cane, on the average of two series of determinations, make one hundred and eighteen pounds of diffusion bagasse, and this has been assumed to be approximately true for the Kansas and Louisiana cane; as this cane is claimed to have ten per cent. of fiber and ninety per cent. of juice, it can be calculated that the one hundred and eighteen pounds of exhausted chips contain one hundred and eight pounds of juice, or that there will be two thousand one hundred and sixty pounds of chip juice from two thousand pounds of original fresh cane. The analytical data applied in these calculations gave the absolute weight of pure sugar left in the chips from each ton of cleaned shreds. At Magnolia, in one experiment, involving several hundred tons of cane, this loss is seen to be 9.5 pounds only per ton of chips; in the other cases on record it ranges from 15.8 pounds to 19.6 pounds of sugar per ton of cane. At Fort Scott the average for the season amounts to 14.9 pounds, and at Rio Grande one experiment indicated 16.8 pounds, and the other 17.6 pounds of sugar.

The extraction recorded against the Rio Grande apparatus is in one case 89.8 per cent. and in the other 85 per cent. The Magnolia records range from approximately 92 to 96 per cent. and average 94.5 per cent. Fort Scott is credited with 91.33 per cent. From this standpoint the Rio Grande battery appears at a disadvantage; it must, however, be remembered that this percentage expression is secured by dividing the absolute loss of sugar by the total amount of sugar present in the fresh cane and subtracting the quotient from 100. If the loss is fixed at sixteen pounds of sugar per ton of cane, the percentage of extraction will be high or low in proportion to the amount of sugar in the fresh sorghum. It is very high in the Magnolia record on cane carrying from two hundred and eight to two hundred and sixty pounds of sugar per ton, and is low in the Rio Grande record, where the cane contained one hundred and seventeen and seven-tenths pounds only of sugar per ton.

As regards the purity of the juices and the extraction of sugar, there seems to be very little difference in favor of either form of battery. The principal difference is seen in the dilution of the juice. At Magnolia the average dilution was 51.5 per cent.; at Fort Scott it was 45.9 per cent.; at Rio Grande in one case it was 10.7 per cent..

and in the other case 4.6 per cent., with a possible increase to 7.5 per cent., as noted on a previous page. The full meaning of this argument in favor of the Rio Grande battery will be illustrated by the following report on the experiments with the open evaporator.

## 5.

## THE COST OF CONCENTRATING DIFFUSION JUICE WITH FUEL OIL BURNERS AND THE EFFECTS OF THIS TREATMENT ON THE QUALITY OF THE PRODUCT.

A description of the open evaporator and of the oil burners has already been given, and it has also been shown that on the average for the season this apparatus removed more than one-half of the water in the diffusion juice, causing thereby a loss in the purity of said juice of approximately one degree only.

Accurate records for the season indicated that thirty barrels of fuel oil, in one case, evaporated the product from ninety-seven tons of field cane, and in a second case thirty barrels of oil were used in handling the product from one hundred and four tons. At two and one-half cents per gallon, a barrel of oil costs one dollar and twenty-five cents. Sixty barrels of oil, worth seventy-five dollars, were, consequently, used for two hundred and one tons of field cane. The oil burned in evaporating one-half of the water in the diffusion juice cost, therefore, at wholesale, *thirty-seven cents per ton of cane.*

These records include all losses and wastes which invariably occur when new machinery is used by inexperienced men. In order, therefore, to secure a more exact record and to detect, if possible, defects in arrangement and management of this apparatus, two trials were personally carried out by Mr. Hughes and the chemist of this Station. The diffusion juice, the semi-syrup and the oil were weighed; the time occupied by the work was noted, and the chemical analyses of both juice and semi-syrup were carried out in the usual manner. The results are as follows:

OCTOBER 29TH, 1888.

| | |
|---|---|
| Pounds of diffusion juice used | 5,086 |
| Pounds of semi-syrup secured | 2,556 |
| Pounds of water evaporated | 2,530 |
| Pounds of oil burned | 498 |
| Pounds of water evaporated per pound of oil burned | 5.1 |

| | Brix. | Per cent. of Sugar. | Purity. |
|---|---|---|---|
| Analysis of diffusion juice | 8.9 | 4.7 | 52.8° |
| Analysis of semi-syrup | 17.8 | 9.6 | 53.9° |
| Time of experiment | 1 hour, 24 minutes. | | |

OCTOBER 30TH, 1888.

| | |
|---|---|
| Pounds of diffusion juice used | 6,007 |
| Pounds of semi-syrup secured | 2,343 |
| Pounds of water evaporated | 3,664 |
| Pounds of oil burned | 476 |
| Pounds of water evaporated per pound of oil burned | 7.7 |

| | Brix. | Per cent. of Sugar. | Purity. |
|---|---|---|---|
| Analysis of the diffusion juice | 10.6 | 5.6 | 52.8° |
| Analysis of the semi-syrup | 24.8 | 12.5 | 50.4° |
| Time of experiment | 3 hours, 28 minutes. | | |

In the first experiment two burners were used. The valves were of such a form that the complete control of the flow of oil was impossible; the work was done rapidly and without injury to the quality of the juice, but the waste of oil was excessive. In the second experiment one burner only was used. This was provided with a globe valve for regulating the flow of oil, a change which resulted in a very noticeable saving in fuel, and an equally marked injury to the quality of the juice. If the evaporation had been hastened by the use of two burners, or if the acidity of the juice had been neutralized by passing it through layers af finely-ground carbonate of lime, it is believed the inversion of the sugar would have been reduced to a minimum.

It has been stated on a preceding page that a ton of field cane contains twelve hundred and fifty pounds of juice, of which one hundred and seventy-five pounds is sugar and other solids, and ten hundred and seventy-five pounds is water. Ninety per cent. of this juice can be extracted, and if this work could be accomplished without dilution, the fuel-oil burners would be called upon to evaporate four hundred and eighty-four pounds of water for each ton of cane worked in the house. Under the conditions of the second experiment, this could be accomplished by burning sixty-three pounds or nine gallons of oil, worth twenty-three cents. The semi-syrup from one ton of field cane would still contain four hundred and eighty-four pounds of water.

Ninety per cent. of the assumed quantity of juice in one ton of field cane is eleven hundred and twenty-five pounds. If this product is diluted by fifty per cent. during the diffusion process, it will weigh sixteen hundred and eighty-eight pounds, and will contain fifteen hundred and thirty-one pounds of water. This involves the evaporation of ten hundred and forty-seven pounds in order to reduce this juice to a semi-syrup containing one-half of the water present in the original cane juice. Under the conditions of the second experiment, this would call for one hundred and thirty-six pounds of fuel oil, or more than nineteen gallons, worth at wholesale forty-eight cents.

A dilution of diffusion juice, amounting to fifty per cent., would more than double the expense for evaporation, or would cause an additional outlay for fuel of twenty-five cents per ton of cane.

With a dilution of diffusion juice of seven per cent., a calculation similar to the above will indicate the use of ten and one-half gallons of oil, worth twenty-six cents.

*If the arrangements for evaporation now in use at Rio Grande remained unchanged, the replacement of the present battery with one similar to that used in Magnolia would involve an actual increase in the expense account of twenty-two cents per ton of cane, or nearly nine dollars per day.*

6.

NOTES WHICH MAY BE OF VALUE IN DEMONSTRATING THAT FINANCIAL SUCCESS CAN BE SECURED UNDER PRESENT COMMERCIAL CONDITIONS, WITH SORGHUM CONTAINING NINE PER CENT. OF SUGAR IN ITS JUICE.

It has been stated that a sorghum sugar-house, with a daily capacity of forty tons of field cane, can be equipped in such a manner that its labor account need not exceed seventy cents per ton. Diagrams of nearly all of the machines needed in this work have been printed either in the Station's eighth annual report, or in the present report. The question as to the sizes and arrangements of this machinery is a matter dependent largely upon experience. The following notes were taken this year, and are recorded for the benefit of those who may, in the future, turn their attention towards this industry.

It has been demonstrated that the cane carrier can transport unstripped and untopped cane on an angle of thirty-five degrees, without

requiring that said cane shall be bundled or bound with rope "slings." This simplifies the field work, and slightly increases that of unloading the cane at the sugar-house. To overcome this trouble, every teamster should be provided with six rope slings, each long enough to bundle four hundred pounds of cane. A "Turk's head" on each end of the lower shaft of the cane carrier would convert it into a steam winch, by means of which the bundles could be lifted from the wagons and drawn into the cane-shed.

The topping and cleaning apparatus can be somewhat improved in one or two respects, particularly by increasing its speed from eighty-eight to one hundred and fifty revolutions per minute. Belts should be substituted for chains in operating the fans, and an increase to perhaps 500 revolutions per minute would probably add to their efficiency.

The shredding apparatus requires to be so modified that the cane shall be made to pass through at least two sets of knives. Mr. Hughes' plans for this change have been developed, and will doubtless lead to satisfactory results.

An arrangement for transferring the cane shreds to the baskets is needed, which will necessitate the employment of one man only, whose duty it should be to pack, to weigh and to immerse the baskets in the eleventh cell. A small carrier, running across the bottom of the shred-bin, and ending directly over the basket, promises at present to solve this problem.

An apparatus modeled after a turnstile has been planned by Mr. Hughes, with which to transfer the baskets from the crane of the eleventh cell to the draining-board, and later to the derrick-arm of the main battery.

The cells of the diffusion battery may be made either of wood or of cast iron; in either case they must be provided with steam coils. If these cells are made thirty-six inches deep, and large enough to just admit baskets thirty-one and a half inches in diameter at the top, twenty-eight and a half inches at the bottom, and twenty-one and a half inches deep, they will doubtless contain the solutions used in extracting the sugar from portions of chips weighing two hundred and seventy-five pounds each.

It is believed that the baskets of exhausted chips should be swung into the space inside the circle of the tanks, in order that the chips may be discharged automatically upon a carrier and removed from

the house by steam-power; this would effect a saving of four dollars daily, the amount now paid for men and teams employed in disposing of this bagasse. Should this plan be adopted, the following modification may be found to be serviceable. The engraving of the diffusion battery on a preceding page, indicates the manner in which the handle or bail is attached to the basket; an iron rod connects the ends of the bail, and serves as a support for the covers used to prevent the shreds from floating out of the basket during the diffusion process. If the baskets were cut into halves down the sides, and across the bottoms, directly under the bail, then this rod could be used as a hinge upon which the halves of the baskets could be raised or lowered at will. If a loaded basket were suspended from two points on its rim diametrically opposite to each other, and at right angles to the bail, then the weight of the load would cause the halves of said basket to divide and discharge its contents automatically; the transfer of the point of attachment of a basket from one of its bails to the other, could, of course, be accomplished with simple machinery.

If the bagasse can be discharged automatically, in the manner above described, the force necessary to operate a forty-ton battery can be reduced to three men per shift.

The seed-tops can be handled by steam power in the following manner: A bin made of slats, like an ordinary corn-crib, narrow at the bottom, relatively broad at the top, and ten or twelve feet high, should be built near the sugar-house; a carrier could be made along the top of this bin, upon which the cane-seed could be transferred and dropped at will, into any portion of said crib. By making this bin relatively narrow and high, the seed-tops would be dried by the wind and sheltered from the rain. It is believed that this arrangement would largely increase the amount of seed at present secured per ton of cane, and improve its quality, by preventing the changes caused by heating and moulding.

A. T. NEALE.

# REPORT OF THE BIOLOGIST.

## OYSTER INTERESTS OF NEW JERSEY.

The Biologist first became connected with the Station in September, 1888. At the suggestion of the Director, Prof. Geo. H. Cook, the condition and capabilities of the fishery industries first engaged our attention.

From Vol. I. of the final report of the State Geologist, 1888, we learn (p. 94) that the water area of the State is one-tenth of the land area (454,423 acres water; 4,809,218 acres land). The relative importance of these two areas is by no means expressed by this ratio. Much of the land is rocky, much is arid, much is swampy; and these tracts are sparsely populated, and can yield only a poor return for man's sustenance without very extended labor being bestowed upon their cultivation. On the other hand, the presence of bodies of water enhances the value of the farms in their vicinity, furnishing moisture to the soil, and drink for man and beast. Mountainous regions, because of the presence of lakes and cataracts, become noted resorts, where mind and body are recuperated by viewing the beauty of the scenery and sporting upon and in the waters.

We shall be interested in these bodies of water only from the point of view of food production they are capable of furnishing, though we have only hinted at a few of the other directions in which they are serviceable. A great zoölogist once said that the land is the home of plants; the water is the home of animals. But we must remember that all animals are ultimately dependent upon vegetable food. There must, therefore, be enough vegetation in the water to support its animal life. This vegetation consists principally of microscopically-small organisms upon which the lower forms of animal life feed, and these in turn furnish food for larger and carnivorous species, and so on.

How is it that the waters are so much more populous with life than the air? Because water is heavier than the air, and can sustain the living things in it at all depths; because it holds air in solution, and also the inorganic principles dissolved out of the soil by the rains and drainage of rivers, in fact all that the plants need for food. Not so the air. Upon dry land the vegetation is confined to the earth's surface, and so are the beasts and creeping things. Only birds and insects live in the air; but these also depend upon the ground for food.

Thus, it comes about that in estimating the productive value of water and land areas respectively, we must not overlook the fact that the latter should be estimated by the surface; the former by the surface multiplied into its average depth. It is yet to be determined how thick the sheet of water should be to yield the same food per acre as the land.

Another fact should not be overlooked, viz., that the waters of the State are mostly in communication with the ocean, whose vast content no monopoly can claim, so that the freely-migratory fishes, which we capture for food upon our shores, have access to the food of the entire ocean. There can be no exhaustion from lack of fertilizers as happens with the land. Even the stationary forms of life on our shores have the currents sweeping in upon them laden with food as fast as it is needed. It is true that if a few thousand bushels of oysters are made to feed from one acre of shoal water, the ground is so exhausted as to require a year's rest. But that one year is sufficient for its restoration, proving how recuperative are the forces of nature in the sea. We have to learn the limits of nature's endurance and not drive her too fast.

It would be no surprising fact if it should be ascertained that the water area of our State was equal to or exceeded the land area in productive value.

Four-fifths of the water area, or 361,967 acres, are tidal waters.* Of this, probably, 200,000 acres are adapted to growing oysters. This fact, as well as the fact that our oyster industry is the most important of all our fisheries, led the investigator to inquire into the state of this business. Accordingly, all the principal oyster points on the coast have been visited, and the more important planters consulted. These planters have had over thirty years' experience in the business, most of them having grown up to the trade. This opportunity is

*Final Rep. Geol., p. 111.

taken of thanking these gentlemen publicly. They have always been courteous and very willing to give as much information as was in their power. The relations established between us have been of a most agreeable nature. As a class, the planters are well-to-do, own comfortable and refined homes, and constitute an important part of the intelligent people of our population.

The tabulated summary submitted at the close of this report shows that less than 15,000 acres are held by the planters, yielding an annual revenue of two and a quarter million dollars to the people of the State, or an average of $140 per acre. Of course, a larger sum is realized from the ground as actually harvested, but only about a third of the above acreage actually is harvested in any one year. A planter requires considerable extra ground, because it takes at least three years for an oyster to become marketable; and besides, if he plants thickly, the ground must rest every fourth year. Some oysters mature more rapidly than others, or are more mature when first put down, or again, do not exhaust the ground so rapidly, that a planter has some ground from which he realizes profit each year, and other ground on which he reaps only every fourth or fifth year. If all the ground is good ground the average annual revenue from a farm should be $250 per acre (at least $200). Let it be supposed, however, that the above 200,000 acres, if cultivated scientifically, will produce only $100 per acre, the annual income to the planters so holding it would mount up to $20,000,000—a sum ten times as great as that now realized.

It will be objected that the demand for these oysters will not be sufficient to keep up the prices, and moreover, that neighboring States, such as Maryland, have even better facilities for producing oysters, so that the market will be glutted. To this we reply that the oyster product of Maryland is dependent upon its natural beds, that these are surely being destroyed, and that it will require a considerable time before people who have been used to taking oysters from natural beds will become educated so as to allow a planting industry to spring up. Meanwhile the population of the country is increasing, and the demand for good oysters will never cease. The community which moves to the front first, in producing easily and abundantly a superior oyster, will reap the benefits.

There is, of course, plenty of room for improvement in the culture of oysters. The Experiment Station has been established for the purpose of ascertaining just how such improvement can be effected.

The real labors of the Biologist lie in this direction. The present report is simply preliminary and introductory. The obtaining of statistics as to the extent of the oyster business has been only incidental to ulterior purposes.

Legislation can do much to encourage this industry by enacting wise laws, and especially by the repeal of, or the refraining from enacting, laws which are a hindrance and work mischief. While this report makes certain suggestions with reference to legislative movements, it is not committed to the enactment of any particular measure now before the people, or that may so come at any future time. The writer advises caution and deliberation; advises better co-operation and patience on the part of the oystermen themselves, until all classes concerned shall thoroughly understand the various aspects of the questions involved. Then, when conflicting interests shall have become adjusted and the welfare of the people as opposed to the demands of private interests of a smaller or larger class of citizens shall be clearly understood, the unified and intelligent action of the parties interested will secure the proper legislation without the friction now supposed to be inseparably connected with the passage of a law.

Of our tidal waters, an area of 100,000 acres produces clams to an extent of nearly $200,000 per annum. This is a source of revenue to thousands of poor people who, under the present conditions of depletion of the oyster-beds, have no other means of earning a livelihood. This industry of gathering clams continues during the greater portion of the year. At certain seasons only, is there a special demand for labor connected with the oyster industry. If means could be devised for securing to these people the ownership of small farms from the area now devoted to clamming, and these farms were planted with oysters, it is plain that the income of these people would be increased one hundred times.

It is customary in reports of this sort to obtain an estimate of the number of people directly engaged in planting, shifting and taking up the oysters; the figures thus obtained are said to represent the number of persons supported by, or dependent upon, this industry. We must not forget that the presence of these persons, with their earnings, calls for the erection and furnishing of their houses; that merchants and mechanics are drawn thither; and that flourishing towns have grown up where there is absolutely no resource for the

people except these fisheries. The land along the greater part of our coast is arid to the extreme. We have summed up the population of the townships that border the coasts where oysters abound, from Perth Amboy southward, deducting the population of the sea-side resorts, and find that we have 62,389 persons dependent upon the sea fisheries of this extent of coast. When we remember that all who bestow necessary labor upon any product, until it reaches the consumer, are dependent upon the fact that the consumer wants such product and is willing to pay to get it, it becomes plain that, as most of these oysters are exported to other parts of the United States, the above figures represent only those who are supported by the *first* handling of the product. Perhaps more than 100,000 people are dependent upon the yield of oysters from Jersey waters.

In this report we first call attention to some facts in the natural history of the oyster, the knowledge of which enables us to breed oysters as we do fish or cattle. It is pointed out that oyster culture will ultimately develop more and more into similarity with agriculture in general, and should be encouraged to do so.

In Section 3 the natural beds are considered. These are now in a state of great depletion, and yield less than 25 bushels to the acre of very small oysters, such as need to lie three or four years longer upon artificial beds to be fit for market. Even this small seed is scarce and growing scarcer and higher priced, so that the planters are apprehensive concerning the future of the business. We recommend that the State allow private enterprise to cultivate these beds, for cultivated they require to be to produce sufficient seed, and public enterprise, it is feared, will be as unsuccessful in securing the perpetuation of these beds under new laws as has occurred under the operation of the old laws looking to their preservation.

In Section 4 the clamming industry is considered. It is ascertained that, important as this industry is with reference to the livelihood of many citizens, the yield of the clamming grounds of the State is much less than for the same area covered by natural oysters, while if it were cultivated by the clammers themselves and devoted to oyster-raising, the income per individual would be vastly greater.

In Section 5 the extent and condition of the planting industry is considered. First, the general methods of planting are explained and reasons are given for estimating the productive value of the tidal waters of the State as potentially $200 per acre (when considered as

producing oysters by the methods of cultivation and planting now in use). Next, the planting grounds are taken up in detail, and in the summary we find that only two and a quarter million dollars (instead of the twenty million dollars per year, of revenue, the waters are capable of yielding) is the yearly income to the people, while this income is produced from land that should pay a tax to the State and should in all respects be treated like other agricultural land. Such a change as this is in harmony with the progress of the industry elsewhere and beneficial to the interests here, and finally, harmonious with the fact that oyster culture, properly undertaken, is exactly paralleled by agricultural processes.

In Section 6 we develop a scheme for experimental research, in which the planters are asked to co-operate for the production of seed artificially and the culture of the oyster bathymetrically, which, if successful, will revolutionize oyster-cultural methods. Finally, we give a summary in a table, and close by once more bespeaking the good will of oystermen and their aid in our work.

## 2.

### SOME POINTS OF PRACTICAL IMPORTANCE IN THE NATURAL HISTORY OF THE OYSTER.

The oyster is a near relative of the clam, resembling it in having two valves to its shell, two pairs of gill folds and the same type of internal structure generally. It differs from the clam in that the two valves are unequally developed, the left being larger and bellied out, upon which the animal lies, while the right or upper valve is flat, or even hollow; also, in having no muscular, plough-shaped "foot," so that it does not move about as can the clam; and finally, in having but one muscle with which to close the shell, and which corresponds to the posterior one of the clam.

It is now believed that there are several species of oyster, of which two, at least, flourish in European waters—*Ostrea edulis*, the French oyster, and *O. angulata*, the Portuguese oyster. The former is *hermaphrodite*—that is, both eggs and spermatozoa are produced in one and the same individual. As is usual in such cases, these generative products do not become ripe at the same time in any one individual, so that cross-fertilization is secured, and the close inbreeding which would result, should an oyster impregnate its own eggs, is prevented.

*Ostrea angulata*, like the American oyster (*O. Virginica*), is

*unisexual*—that is, during any one spawning season a specimen is either a male (producing spermatozoa) or a female (producing ova). Whether the sex remains constant throughout the life of an individual is, so far as the writer knows, undetermined.

*O. edulis* is also *viviparous* as well as hermaphrodite—that is, the eggs are impregnated and undergo development to a considerable extent before they leave the body of the mother, or are "spawned" out to shift for themselves. *O. Virginica*, as was first shown by Brooks in 1879, is *oviparous*, like ordinary fishes, in that the eggs, as well as the milt, are spawned into the water, there to take the chances of being found by the spermatozoa and fertilized. If not fertilized, the sea-water rapidly destroys them.

These ova are exceedingly minute, being only $\frac{1}{500}$ of an inch in diameter, and as many as 60,000,000 can come from one large spawner. The individual cells or spores of the milt are many times smaller and more numerous. This vast number is required, to be in proportion to the chances that any one oyster will not survive to be marketed for the delectation of the epicure. If the chances are that the oysters, by the action of various enemies and mud, are likely to be decimated the last year that they lie on the beds, the chances are that a fourth will perish from these causes the preceding year, and so on, the increase in mortality rising to prodigious proportion as the oysters are smaller and smaller. We may be thankful if, in a state of nature, one out of a million young, lives to be of marketable size. While the oyster is minute, the number of small enemies that wait to eat it is practically unlimited. Then, too, a sudden change in temperature, a storm, &c., will slaughter the spawn by the wholesale. No wonder that there are seasons when no catch or set of spawn occurs.

After fertilization, the egg develops rapidly into a little swimming embryo, and in a few days it seeks a place to settle down for life. This place must be some clean shell or pebble or stake. Even then, should a sediment as thin as a sheet of paper settle upon it, it is smothered.

As it grows there are larger enemies waiting for a savory mouthful, such as starfishes, drumfish (*Pogonias chromis*), the small black winkle (*Trittia trivittata*), the "drill," or "borer" (*Urosalpinx cinerea*), and other fish and shellfish; also sponges, and worms, and eel grass, &c. When crowded, the oyster becomes its own enemy, and in the

struggle for existence the topmost oysters overspread and crowd down into the mud to smother, their less favored brethren.

Such are the wasteful methods of nature. Man was created to subdue the earth, to cultivate the forces of nature to his own advantage, and, in so doing, not only does he reap the physical reward of his labor, but, by the exercise of mind needful to understand the laws of nature, his intellectual and spiritual endowments are increased, new capacities for enjoyment are possible, and new wants arise that lead to new industries for the support and benefit of the increasing population. We find everywhere the verdict of history is that progress from barbarism to civilization has resulted in proportion as man has cultivated, has controlled, the forces of nature.

Where nature furnishes food that can be procured with the least mental effort, there the people are low in the scale of civilization. The Indians of our country relied on what nature furnished, and cultivated the ground only in the rudest manner. They came and gathered from the natural beds such oysters as they wanted, and were content. The Indian has given way before the intelligent European, who tills the soil and harvests his crop, and breeds his cattle in accordance with scientific principles, and who *experiments* to learn more about nature's methods.

It is precisely in the earliest stages of the life of the oyster where the care and culture of man will count for most. Here, as in other directions, the rewards for such care will be great.

The history of the oyster industry has been, in the oldest and most intelligent communities, as follows: First, the natural beds were drawn on until they only furnished seed. Then this seed was transplanted and handled scientifically by planters. Next the natural beds became utterly depleted, and the planters were forced to raise seed of their own, first by placing "spat collectors," such as shells, brush, &c., in natural waters, to catch, at random, the spawn furnished by nature, later by putting "spawners" with such collectors to insure a catch, and lastly by approaching the methods used in modern fish-hatching, where each step of the process is carefully guided, the eggs artificially fertilized, the young placed in appropriate waters, and finally distributed to the points where wanted.

Oyster culture approaches more nearly to agriculture than does fish culture, in that, like the vegetable, the oyster is a stationary organism. It therefore becomes necessary, and of advantage, to cultivate it

under similar conditions. Private farms have been granted (in the progressive countries), paying taxes like other farming land, and owned and transferred like real estate. The change in oyster culture from its primitive conditions to these conditions has thus been similar to what took place when the American Indian was supplanted by the European farmer.

The inevitable result, viz., the depletion and ultimate destruction of the natural beds of oysters, leads to an improved method of rearing oysters and to the advance of civilization. Hence, the remedy to be applied whenever such a fact as the deterioration of oyster-beds becomes patent, is not for the State to restore the natural beds (which is of the nature of a work of charity and only of temporary benefit), but to encourage the more stable methods of oyster culture by experiments leading to the discovery of practicable methods of raising oysters artificially and by appropriate legislation, granting farms to oyster planters, from the tidal areas.

It is, therefore, a happy occurrence that the natural beds are being destroyed; a primitive method of living by simply picking up food becomes superseded by intelligent farming. The different pests and enemies that attack oysters are to become as much a subject for study as are the pests of the crops of the inland farmer. A knowledge of the laws of reproduction of plants and animals has led to the intelligent breeding and the establishment of races of valuable domestic species. This is to be duplicated in oyster culture. Here, as elsewhere, the highest sort of scientific investigation, often looked upon by the uninformed as "theoretical," has the widest practical application. It was the most theoretical and philosophical of American zoölogists who made the discovery, according to which it is now possible to rear oysters artificially.

In all respects, therefore, oyster culture and agriculture are similar and require similar legislative conditions and relations to the State. The State is entitled to a revenue from its tidal waters, when cultivated, as well as from its farming lands.

### 3.

### EXTENT, PRODUCT AND CONDITION OF THE NATURAL BEDS.

A "natural" oyster-bed is a ground where oysters grow, without any assistance from man, in sufficient quantities to pay for gathering oysters from it for commercial purposes. What no man has been

concerned in producing belongs equally to all, when upon public land. This does not refer to the ground, but to the crop upon the ground. If from any cause, as from excessive tonging, the oysters be taken away and no new ones appear naturally in their places, the bed, as an oyster-bed, ceases to exist, as has happened in Europe and on our northern coasts, and at Shrewsbury in our own State, and will happen at no distant day in the Chesapeake.

The reasons why the bed exists, or existed originally, are these, viz.: Suitable objects, such as stones, to which the young oyster could fasten, were present on the bottom, and when once the "set" has been made, the shells of preceding generations serve as collectors for the succeeding ones.

Wherever the water is of proper saltiness (at least 3 per cent.) and the ground is washed by the outpourings of fresh-water streams, there the oyster will flourish. The reason that all such waters are not stocked with oysters by nature is because, firstly, the currents do not run so as to sweep "spawn" thither from already-established beds, or secondly, if they do, there are no suitable "collectors" for the "spat" present.

Clearly, if shells be placed in such situations, a bed will be established. However, nobody will take the trouble to do this while the public consider such bed as common property. The State could undertake the work and thus largely increase the available supply of oysters. This is sometimes advocated under the plea that the poor would thereby be benefited, while the planters could get cheaper and more abundant seed. We think the State can pursue a wiser course by handing over such work to private enterprise, which is "the most efficient agent for the preservation and development of natural wealth." *

We shall now consider the natural beds in detail.

*Newark Bay.*—Here are natural beds extending from a little ways up the Passaic and Hackensack rivers, down through the sound and Arthur Kill to near Perth Amboy. Natural oysters are found all the way up the Hudson as far as the State line, but no beds, in the proper sense of the term, exist now. In Newark bay itself, according to Captain Joseph Ellsworth, only one-fourth of the area, or about 1,000 acres, is occupied by natural beds. Here, as elsewhere, the supply has been so persistently drawn on, the oysters being taken

* See p. 105 of Brooks' Report on the Development and Protection of the Oyster in Maryland. 1884.

away as fast as a "set" is established, to furnish seed to be planted in the Raritan bay, &c., that the amount of seed obtainable depends upon the extent of the set, so great is the demand, which always outruns the supply. Last season there was no set in the bay proper, so that what was taken belonged to the set of the previous season. The large oysters found here are not marketed until they have lain a season upon artificial beds to correct their "greenness."

Some seed from these beds is shipped by J. & J. Ellsworth to California. Only the smallest-sized seed is so shipped. In 1886, 30,000 bushels were shipped. In 1888 only 11,000, owing to scarcity of the supply. It is claimed that the reason there was no set in the bay is because the shells have not been stirred up enough to keep them bright (no dredging being allowed, except in Delaware bay). On the other hand, we may feel confident that the beds were not worked, because of scarcity of oysters upon them. Even if the law, which requires that dead shells be thrown back upon the bed, were observed (which is far from being the case), still the number of shells available as "spat collectors" must steadily decrease while the demand for seed is so great. This demand is not likely to lessen, but rather to increase, while everywhere the supply is rapidly falling off. The result is to raise the price of seed, and of oysters generally, and to make the raising of seed by artificial means so profitable, that many will undertake it until a proper balance is restored.

*Raritan River and Bay.*—Practically the natural beds are restricted to the Raritan river from Perth Amboy to Sayreville (about 5 miles, of an average width of half a mile), perhaps 1,000 acres when the channel is subtracted; but not nearly so much seed is produced here as in the waters just discussed. Probably the acreage assumed is too large. In 1886 only 3,000 bushels of seed for the California export was obtained here. Small beds have been lately discovered at Flynn's Knoll, near Sandy Hook, probably produced by the accidental dropping of shells from a passing boat. The Raritan beds are very much depleted. Capt. T. S. R. Brown, of Keyport, informed us that formerly a boat could gather 30 to 40 bushels a day, whereas now only 3 to 6 bushels can be taken by a boat in one day. The cry of the Perth Amboy and Keyport planters is for more seed, and that the State should plant shells upon the beds.

*Barnegat Bay.*—Passing southward no natural beds exist until we reach Barnegat bay. Here the entire bay, of an average width of three miles, south of Toms River to near Barnegat, a distance of nearly 10 miles, and including about 19,000 acres, produces oysters naturally, though the celebrated Cedar Creek beds are the ones mainly relied on. About 13,000 acres may be set apart as including the workable beds. According to L. G. Mitchell, of Barnegat, "This forms one of the finest natural oyster grounds in the State," but is now "almost depleted and likely to remain so unless the State takes it in hand. I would heartily recommend that the State make a survey of the ground from Forked River to the railroad bridge (near Toms River, a distance of 7 miles, including about 13,000 acres), survey it into twenty-acre lots and sell leases to individuals, for, say, 20 years at a time, stipulating the same shall be devoted to seed culture, &c.; or else shell the ground itself, and sell the seed at a moderate rate, enough to cover expenses of seeding and watching, &c. The first-named plan would, I think, be more practical."

This appears quite plausible; yet, if a recommendation were made, in case, for instance, farmers were dependent upon natural beds of potatoes for seed, that the State go into potato culture upon land hitherto considered public property, that it appoint special police to watch such grounds, and that it sell potatoes to the farmers so they could plant potatoes upon their own grounds, on which they paid no taxes to the State, and from which large returns were realized, how would it appear to the public? It is for the interest of oyster culture, and thus of the whole people, that the tidal waters of the State be considered as is the rest of the land, and be held under similar restrictions, modified to suit the conditions of the case. Then let the oystermen work the land as they see fit, with no more legislative restrictions than are used in the case of farmers. The planters will work for their own interest. If dredging hurts the oyster, there will be no necessity for laws against dredging; and so on for other restrictions.

If this seems a radical change, let it be remembered that we will have to come to this point sometime, that the interests of all concerned are best promoted by such a change, and the community which makes the change first, reaps the benefits. Let the oystermen discuss this point; let them consider the question from this broad outlook upon the future, and when they shall agree as to what is best, let them move to secure appropriate legislation.

According to Joseph P. Haywood, of West Creek, the seed that comes from Cedar Creek is better culled than any other. If this be true and still the grounds are being depleted, what can legislation do to avert the result?

The beds of the Chesapeake are being depleted so that Lieut. Winslow, in 1878, found only 5 bushels (at 400 oysters to the bushel) of oysters to the acre in Tangier sound, and, on the same ground, Dr. Brooks, in 1884, found only half as many. These beds, to start with, were doubtless like many other beds that years ago were reported as having a layer of oysters on them "several feet thick."

*Mullica River, Egg Harbor, &c.*—In Little Egg Harbor are about 5 acres of natural oysters; but it is in the Mullica river that the extensive beds, known as the "Gravelings," are situated. The bottom is composed of gravel, to which the spat fastens, and hence there is no need of shelling this bed. According to Ernest Ingersoll, in his report on the Oyster Industry, in 1880, these beds cover several square miles in Great bay, as well as extend several miles up the river. According to John T. Burton, of Tuckerton, they contain, at present, 50 acres, and extend from Bass river to Oyster creek. If we consider the latter estimate as being the area of the beds themselves, and not the area of the entire surface including the beds, we may provisionally assume 4,000 acres as being this including area. If this estimate is too high, it will only decrease the number of bushels, which, in the final estimate, we have calculated are produced per acre from the natural beds. As this is a great clamming point, where the clammers look with distrust and antagonism upon the encroachments and growth of the oyster industry, this large area is taken, that in estimating the relative value of oyster land as compared with clamming ground, there shall be left no cause for supposing that the value per acre of the oyster ground has been put too high, it being borne in mind that in reaching this estimate the yield is divided by the area.

In Great Egg Harbor, several years ago, 100 to 200 bushels could be taken by one boat, without a change of moorings. Now, the cry is, "more seed." Further south, in the creeks of Cape May county, there are natural oysters; but the water lacks lime and saline material, and the oysters are ill-shapen and not in good repute among planters. The amount taken is only nominal.

*Delaware Bay.*—Here the natural beds extend from Egg Island point to Stony point, on the Delaware river, a distance of 30 miles, including over 60,000 acres in Jersey waters. The beds included in Delaware State are so inferior in their yield that Delaware planters obtain seed from the Jersey side, the seed being first run to Philadelphia and sold there, to evade a technical point in the law. Some Jerseymen plant also on the Delaware side. Ingersoll estimated that the amount of seed planted in Delaware waters from these beds amounted to two and a half million bushels. These figures were obtained by considering that 300 vessels were registered as working in the beds in transporting and planting seed, and that each delivered 20 deck-loads of 400 bushels each. It is plain that if each of these factors is excessive, the error will be multiplied accordingly in the result. We have reason to believe this estimate is excessive.

Capt. L. E. Yates informs me that one and a quarter million bushels, in round numbers, were obtained this past season, of which 312,500 bushels were transferred to the Delaware side. Meanwhile, since Ingersoll's report was written, there has been an increase in the business, the number of large planters has increased from 8 to 20, the number of boats registered at Port Norris is now 385, the ground has been extended from the 6,000 acres in 1880, until now an area of 70 square miles is covered by the operations, and "more seed is planted now than ever before," to quote Capt. Hearn, of Port Norris. We can take the estimate of L. E. Yates as probably correct. Two hundred boats are engaged in taking the seed from the beds; allowing each 200 bushels to the load, 30 trips by each and every one of these boats are required to transport the million and a quarter bushels. These operations extend through April and May to June 15th. This allows 740 trips being made, on the basis of one trip per day for each fair day, estimating four fair days per week.

Here, as elsewhere, the cry is "more seed." Some advocate that the State close the beds for two years, to allow the ground to recuperate. But it would take only one year to deplete it again. Others think there would be seed sufficient, if the planters did not plant so thickly, and if the law were better observed with reference to stopping June 15th and to culling back the shells. Dredging is also supposed to injure the young and tender shells, and so the seed that is planted dies, which compels the planters to "sow thick."

The general remarks we have made under the preceding heads

apply also here, viz., that it is of advantage that the business should increase, and that more people should engage in it and share the profits, so long as each makes a comfortable living. This is of benefit to the State, much more than if a few reap large profits. The State should, while strengthening the oyster-planter in his title to the land he cultivates, also see to it that no one planter be allowed to monopolize a large extent of territory.

*Summary.*—The total area of natural oyster ground in the State is about 80,000 acres. The production of seed is in round numbers 2,000,000 bushels, giving 25 bushels to the acre, which at 25 cents a bushel, the average price of seed, gives us such ground as yielding $5 per acre per annum. But it must be remembered that the oysters are scattered over this area in patches, so the yield, per acre, of actual oyster ground is much greater.

The whole of this ground, if planted with oysters and under cultivation, would yield a revenue forty times as great as it now yields. Even if one-half of this area were devoted, by private enterprise, to seed-raising alone, it would yield seed sufficient for a long time to come.

But if this be advocated, what will the average "'longshoreman" say? It is evident that as many of these people as possible should be allowed and encouraged to take up farms, and be instructed in their management, &c. With those who were still too restless to settle down to so regular and scientific a business, a compromise could be made. The best clamming ground could be set apart for a series of years as public commons, not to be open to planters to place oysters upon it, except that those now upon such grounds should not be driven off. There should be allowed no trespassing of oystermen upon the clamming grounds, under penalty of forfeiture of stock so planted, and on the other hand no clammer should ever be allowed to search for clams upon private oyster-beds if the owner objected. There are other compromise measures thinkable, such as dividing the natural beds into alternate strips of "commons" and private grounds; or, the natural beds could be open to the public for a short period each year under the proviso that oysters taken should be of a certain size and not smaller. The private owner could be left to treat his own farm as he pleased, raising seed or marketable oysters at his discretion; or, according to the suggestion of L. G. Mitchell, of Barnegat, he could be required to devote his lot to seed-raising.

We shall hereafter discuss a plan for getting seed more in accordance with agricultural methods. In agriculture, each man raises his own seed, or else he buys of some one who raises it as a specialty. The product of a single spawner is sufficient for a pretty large farm, if properly reared and taken care of in the early stages.

## 4.

### THE CLAMMING GROUNDS.

Whereas oysters are taken only at stated times, clams are gathered all the year round, excepting when the bays and creeks are frozen. Many a poor man depends upon this occupation for a livelihood, although his daily earnings from this source are sometimes very meager. No wonder he views with alarm the encroachments of the oyster-planter and feels tempted to hunt for his clams upon his favorite ground after the planter has sown it with oysters. It is admitted, even by the planters themselves, that the clammers generally leave the oysters alone, but some planters have had their oysters injured and buried in the mud by the operations of the clammers, and they say that more dollars' worth of oysters are destroyed than dimes' worth of clams are obtained. They claim to have offered to pay the clammers in advance as much as they expected to gain by going upon the beds, if they would keep off, but with no success.

We now take up a more detailed consideration of the clamming grounds.

*Raritan Bay.*—According to Capt. Beadle and T. S. R. Brown, of Keyport, four-fifths of the ground between Sandy Hook and East Point is used by the clammers. This makes an area of 28 square miles or 18,000 acres (nearly) of clamming grounds. In the *Keyport Enterprise* of October 23d, 1886 (loaned me through the kindness of the editor, Mr. Fred. Armstrong), is a list of 109 boats operated by about 300 men, including the captains, engaged in taking clams every fair day during a period of about 40 weeks each year.

Each boat is estimated to average $10 per day, which, allowing 160 working days (an average of four fair days per week), aggregates the sum of $1,600 per year for each boat. There are also 30 smaller boats that average $3 a day, or $480 a year. It is always difficult to get an average just right. If it is a little too large, the error is correspondingly multiplied in the result. It is much more

accurate to guess at the total and from that to compute the average. Capt. Brown estimated that about 80 sloops were engaged upon the above ground in taking clams, realizing $1,000 apiece. Besides these, there are from 300 to 1,500 small boats, that take one-fourth as much more. This estimate is for last season, which was poorer than the average.

According to the first estimate, in round numbers, $200,000 per year is annually earned by Keyport men in clamming. According to the latter estimate, the product of the entire area amounted to $100,000 for the past season. This appears the more probable estimate, as it is doubtful if a majority of the sloops actually realized as much as $1,000. Assuming, however, that the figures could be doubled for a good season, we will place the average at $150,000. This gives an income of less than $12 per acre, which compares favorably with the income per acre from the natural oyster-beds, but is only a twentieth of what could be realized if the ground were cultivated for oysters. Estimates of the clam production in other parts of the State, compared with the above estimates, show that the Raritan beds are four to six times as valuable as any other. This is improbable, hence the above figures must be considered to be excessive.

*Little Egg Harbor, Great Bay and southward to Cape May.*—The principal grounds are at Little Egg Harbor and Great bay. People from as far south as Cape May come here to "clam." The clams are shipped from Tuckerton, Absecon, Pleasantville and Somers Point. According to F. R. Austen, the export from Tuckerton the past season reached 11,000,000 clams, worth $20,000. Clams are worth 60 cents a bushel, at 300 clams to the bushel. A bushel of oysters averages 250 oysters at $1. The above 37,000 bushels (or less) of clams, is the equivalent of 20,000 bushels of oysters, so far as the income is concerned. The income from clams is held to be more important, because it is distributed among many more men, and throughout a larger portion of the year.

The extent of the clamming ground could not be ascertained, except that the "clams are found about everywhere." The area of Little Egg Harbor and Great bay is, for both together, less than 30,000 acres. Might not these figures be taken to represent the area of clamming ground along the whole ocean shore? As we have estimates only of the clams that leave Tuckerton and the above-men-

tioned points, let us assume that all the clams thus exported come from 20,000 acres of ground in Little Egg Harbor and in Great bay. From Absecon a "half car-load of clams and oysters leaves each day from September 1st to June 1st." In the summer the principal shipment is oysters. This estimate gives, then, 7,500,000 clams, as shipped from this point each year. Next let us take Pleasantville. According to S. Fish, of Smith's Landing, the clamming interests have declined to one-third of what they were in 1880. Only 1,000,000 clams, worth $2,000, are exported, one-tenth coming from 200 acres of clamming ground in Lake's bay, the bulk coming from up the coast as far as thirty miles away. Next pass to Somers Point. According to W. H. Keates, the shipping agent of the West Jersey railroad station here, 5,000,000 clams is the maximum shipment in a year, the amount being but 3,500,000 the past season. The grand total is 25,000,000 clams, worth $50,000, which, if all are considered as produced from 20,000 acres, gives the maximum income from the clamming grounds at $2.50 per acre. Even the lowest estimate for Raritan bay gives $4 per acre, which, if true, makes the latter grounds twice as valuable as those near Tuckerton. If the grounds be supposed of equal value, we must conclude that only about one-third of the ground in Little Egg Harbor and Great bay is good clamming ground, or else that the number of acres for Raritan bay is taken several times too large. These calculations make us seriously to suspect that the clamming grounds of the State are worth much less than the natural oyster-beds per acre—less than half as much. But the oyster grounds yield only a tenth or a twentieth of what they ought to yield and can reasonably be expected to yield if cultivated.

*Delaware Bay.*—No clamming interests are involved in Maurice river cove operations. The clamming grounds lie to the east, near Cape May. Both the oysters and clams of this region are largely used at the Cape May hotels. We lack $30,000 to round out our clamming estimate for the State to $200,000. This value of clams requires about 20 square miles, or roughly, 15,000 acres, which pretty well covers one-half the area of that part of the bay. In the absence of data from which to determine an estimate for this region, we may take the above figures as very likely more than covering the actual harvest.

*Summary.*—We thus have, at a minimal estimate, 70,000 acres of tidal waters in the State that produce clams in such abundance as to furnish an industry to the people. As a maximum estimate the value of these clams is $200,000, which gives $3 an acre as the maximum revenue derived from this area; $1 per acre being a minimal estimate and $2 an average. It is plain, even if these estimates be considered as varying widely from the truth, if such were possible to attain, that by no sort of calculation can clamming ground be made to exceed in value our natural oyster grounds. It is easily seen that our natural oyster grounds are not one-tenth as productive as the cultivated oyster lands. Whatever, then, be the sentiment of the clammers themselves, if it were possible for them to own a part of the clamming ground and could be induced to plant it with oysters, they would reap an income many times greater than they do now.

5.

## EXTENT AND CONDITION OF THE OYSTER-PLANTING INDUSTRY.

*Why Oysters are Planted.*—Upon the natural beds the spat fastens upon the shells of the former generations, so that the new crop smothers the old. The new set is itself crowded, so that the oysters in bunches, struggling for existence, grow long and "straggling." When such bunches are broken apart and the oysters are scattered over new ground, in salter water, they are stimulated to grow faster, to fatten into condition for the market, with better flavor and a better shape. Under fair conditions an oyster is marketable when three years old. The spawning season begins about June 15th and lasts about two months. Planters get their seed either in the spring, during April and May, or in the fall. If the seed is obtained in the spring the youngest oysters present are nearly a year old, if in the fall they are only a couple of months old. One month after spawning the young brood is visible as "blisters" upon the shells to which they have attached themselves. It is plain that the older or larger an oyster is when taken from the natural bed, the shorter time it needs to lie before being marketable. Hence, when oystermen first planted from the natural beds the oysters matured in much shorter time than they do now, that the natural beds are kept depleted, and the age of the seed averages but one year or less.

When oysters are taken up for market they are separated into lots of various sizes, to be sold at prices varying with the size and condition of the oyster. Young seed, when abundant, sells at 10 cents a bushel; the older seed, when "culled"—that is, when dead shells have been picked out of it—sells at 40 cents, and sometimes 60 cents, if scarcity prevails. The average price of seed may be put at 25 cents. In the same way, averaging the prices of the oysters marketed, an average of $1 per bushel will not be far from the true average, when a large amount, as when the product of the entire State, is considered. The smaller oysters are either exported to Europe or are sold to the hotels at the sea-side, where they are kept for several months on the bars to further fatten and grow. If a planter raises oysters for such a market as the one last mentioned, and can obtain seed of fair size, he allows it to lie only one year upon the beds.

Another factor also must be considered. Some seed grows faster than others; southern oysters in northern waters outgrow the "natives," and soft-shelled oysters grow faster than those with hard shells. Then, too, if oysters are planted as thickly as 1,000 to 2,000 bushels to the acre, the amount of food available for each oyster, especially if it is near the center of a large field, is small, and the growth is less than if oysters are planted as thinly as 200 to 300 bushels to the acre, and in small and widely-separated lots. All these questions must be taken into consideration in oyster-planting.

The nature of the ground, whether sandy or muddy, has much to do with the rate of an oyster's growth. More food, especially of a diatomaceous character, is found upon mud flats than over sand. The *diatom* forms the principal part of the food obtained by oysters lying upon the sea bottom. What the oysters that live upon piles and rocks, in elevated positions, live on, has yet to be determined.

As a general rule, the longer an oyster lies the more valuable he becomes, so that it pays better to buy small seed and raise large oysters than to let oysters lie only one year, the increase in price being faster than the increment in time. An oyster one year old may be considered worth 25 cents to the bushel; when two years old the price is 60 cents; and when three years old it is $1. The actual rate of increase in value is, of course, much greater; for it takes fewer oysters to make a bushel at a dollar than at 60 or 25 cents respectively.

There is, however, more risk connected with allowing an oyster to lie three years upon the same bed, than if it lies only one year.

The risk is much greater in winter than in summer. The principal enemy of the oyster is mud and shifting sand. As the oyster cannot move, it is smothered when covered up by mud or sand, it requiring much less to kill a young oyster than an old one. Thus it happens that the mortality is so great that, taking the product of the State in its various conditions, we can expect that the crop harvested will not exceed, but will nearly equal, the amount in bushels of seed planted.

At the present prices the increase in value of oysters as they become three and four years old is so great that planting pays, even when the same number of bushels are harvested as are put down. Those who sow thickly expect a less increase than those who sow thinly, but have a correspondingly small area to cultivate.

It would seem at first sight, if a planter harvest 2,000 bushels from an acre, that the income from an acre of oyster land should be $2,000, the profits of which would be found by subtracting cost of seed, planting, harvesting and marketing. Such is not the case. The average annual income for all planted ground may be placed at $250 per acre. This can be made plain as follows:

If the planter has just harvested a crop, and he proceeds to plant the ground thus laid bare, it will be at least three years before this new crop can be harvested. To have a harvest every year he must have several plots of ground which have been planted successively. If the practice has been to plant thickly, the oysters, as they grow, will crowd each other and will require to be shifted upon new ground of larger extent. This shifting is done the last season to prepare them for market. The oyster is also benefited by the change. So that in the history of a marketed oyster, it has twice been artificially shifted or transplanted—first, at the beginning of its career, and secondly near the close. Nor can ground that has been thickly planted be used when cleared of the crop which has lain upon it two or three years, but in practice it is allowed a year's rest. Thus it happens that, in cultivating native oysters from the seed, when 1,000 bushels are placed upon an acre, that two acres of ground are required before it is marketed, and that to market 2,000 bushels, supposed to result from 1,000 bushels of seed, *every year*, requires as many times more ground as it takes years to mature the oyster. The ground upon which the last shift is made is used every year; and in general when oysters are to lie but one year the ground is not allowed to rest as often. Hence it comes about that, for the whole State, an area of ground for all oys-

ter operations (so long as seed is grown to a greater or less maturity elsewhere before it is planted) that three times as much ground must be held as is harvested each year.

For the full operation of raising native oysters from the spat, seven acres are needed for every acre put to seed, as can be seen from the following diagram, which illustrates the practice at Keyport as explained to me by Captain Beadle:


Let this diagram represent an oyster farm just claimed and not yet under cultivation. The planter, if he wishes to plant an equal amount of seed each year, first plants lot 1; the next year lot 2 is planted, the third year lot 3 is planted, and the fourth year lot 4 is planted, and the three-year-old oysters on lot 1 are taken and spread upon 6 and 7. The next spring lot 1 has had only a winter's rest, and so lot 5 must be planted. The oysters upon 6 and 7 lie only during the summer, but sometimes also the winter, too, when they are marketed the next summer and not in the fall. When 6 and 7 is clear and has had its winter's rest, the oysters on 2 are shifted to it and lot 1 is planted, while 2 rests and so on, year after year, the planting being done in the spring and the harvesting in the fall. Under this system oysters are nearly one year old when first planted and four years old when marketed; but they are technically known as three years old, because they have been that long under cultivation.

Southern seed is supposed by some to exhaust the ground faster than native seed. It grows faster and is planted more thickly, but does not endure the northern winters well, though in Barnegat bay where it spawns so profusely as to injure the planted oysters, it is claimed that the *offspring* of the southern oyster are better acclimated. In Raritan bay and northward it has not been known to spawn. About one-fourth as much southern seed is planted in New Jersey as native seed (the amount growing less year by year). This gives about 2,250,000 bushels as the total annual plant for the State. Ingersoll gave the same figures eight years ago; but there is evidence of nearly

a one-third increase in the amount planted since 1880, when planters' estimates of growth of the industry at different points have been averaged.

Granting that the lots in the above diagram are acres and that 2,000 bushels are harvested each year from 6 and 7, a farmer then realizes $2,000 from 7 acres each year. That is nearly $300 per acre. If he gets back an amount equal to the seed he planted, the returns will be $150. This figure must be increased by considering the fact that one-third of the plants are on the same ground every year, so that $250 to the acre is considered an average yield. If the estimate of all the ground planted is compared with the total product of the State, we get $140 per acre as the result. Our estimate includes more than the actual ground under cultivation, but also the entire ground held or operated upon (as it were in patches), so that we have no hesitancy, in view of these facts, in placing the productive value of ground capable of raising oysters at $200, as the business is at present conducted.

Upon the natural beds each succeeding year's crop struggles for existence with the preceding year's crops upon the same ground. Under the system of cultivation each season's crop is given its own ground, and if all the seed lived it would become necessary to increase the area of the plant by shifting each year until the oystere were marketable. Such, practically, is not necessary, except to the extent of doubling the area planted in the final shifting. Under a system of planting to be described further on, this increase in the area for the final shifting becomes unnecessary.

It must always remain a fact that the oyster requires to be shifted, and that new ground must be had for the new generations until the old generations are marketed. This ground must be paid for, and when an oysterman buys southern seed he is paying the southern oysterman for devoting ground to the raising of it. As an offset, he has so much more ground himself for the further maturing of the oyster. But always the same ratio of ground to the amount raised must be maintained. If it should happen that it is more profitable to raise oysters in their later years than in their earlier, it would follow that no one would try to raise seed, and so scarcity would ensue until the price of seed rose to a figure to make it profitable to raise it. Matters will thus tend naturally to make the increment of value of the oyster more nearly correspondent with its age. If certain localities are bet-

ter adapted for raising seed than other localities, such localities will win in the competition and get the market; thus it may happen that, as in agriculture, seed will be produced by specialists.

We call attention to these points as bearing upon the consideration of the natural beds. The most efficient way of raising oysters is to have but one crop upon the ground at the same time. The demand upon the natural beds is so great that each season's crop is taken as fast as produced. This result is inevitable, and when reached, it is the ideal condition of things. The only question is, can enough seed be raised by natural methods upon these beds? We must answer no. The beds must be put under cultivation for the purpose of raising seed. That this branch of industry, when put into private hands, will pay, is evident.

From the report of the shell-fish commissioners of Connecticut for 1883, we learn that millions of bushels of shells have been planted on private farms and have become covered with blisters, and that "one cultivator alone looks for no less than 1,000,000 bushels of marketable natives from his own grounds." In this way, in favorable localities, each planter can convert his farm into the same sort of a bed as a natural bed is before it is depleted.

Now, the question is, shall our cultivated beds be transformed into such beds, where each succeeding generation "blisters" the preceding? Shall our waters, when given over to private enterprise, become a vast natural bed which is kept from depletion because the private owner is interested in keeping it well supplied with shells, or shall certain planters "shell" afresh a certain patch each year, catch the spawn and sell it as seed to other planters? Shall there be specialization, or shall the primitive condition of things be restored, except that the oyster-beds are monopolized by the few?

We don't believe that the latter plan is best. What an immense amount of culling must be done when the artificial imitation of a natural bed is dredged! What a lot of blistered oysters! We don't think this looks like scientific farming. We propose to develop a different plan and leave time to decide which is the more profitable. We propose to turn all natural beds into beds to receive seed in successive additions and to have but one crop upon the ground at a time. Our plan is not original. It has been in operation for years in Europe; and in America experiments that show its feasibility have actually been performed several years ago by John Ryder, of the

Fish Commission. But we leave the development and application of these methods to the next section.

Meanwhile we turn to consider our planting grounds in detail:

*Perth Amboy.*—I am indebted to David and James Noe for information on the planting, and to Captain John C. Heney for statistics on the production the past season at this point. 100 acres are under cultivation and some additional plots near Keyport. 45,000 bushels of Raritan and Newark bay seed were planted and 60,000 bushels harvested last season. Three-fourths of the shipment goes away by rail, including some raised on the Staten Island side (which is not counted in the above figures). The planters here wish the mud strips that separate the natural beds, could be shelled, either by the State or that the State encourage some one to do it as a private venture. There are more men now in the business than ten years ago and the competition is sharper, and the amount of seed available is scarcer. The flavor of the oysters is not up to standard, supposed to be due to the effect of the refuse from factories. A steam dredge is hired at $40 a day to take up oysters. Mud is the worst enemy and prevents a large extent of ground from being used.

Ingersoll's figures for Perth Amboy are 100,000 bushels for 1880. Probably the Staten Island product is included.

*Keyport.*—I am indebted to Captain Beadle, T. S. R. Brown, T. C. Mason and William De Groff for information at this point.

The cultivated area forms a patch opposite the town, containing two and one-half square miles (according to a survey made by George Cooper, of Red Bank), about 1,600 acres, not all of which is under cultivation. There are over 40 planters, owning each from 2 to 10 acres. About 200 acres are devoted to southern stock, and of the remainder probably only 800 acres are planted with "natives." East river seed is not in favor here, the theory being that an oyster to do well must be planted into water salter than that from which it came, or at least not fresher.

The business the past season is not up to the average, although there has been a slight increase over 8 years ago. Summing up the amounts produced by the different planters gives 210,000 baskets of 5 pecks each, equaling 262,500 bushels. But one-third of what was expected was dead when harvested, the real amount taken up being

toward 400,000 bushels. The amount of Chesapeakes handled may roughly be taken as equal to this extra third, and so we can place the amount of native seed represented in the above harvest at 200,000 bushels, at an average cost of 40 cents.

Ingersoll's figures for 8 years ago give 25,000 bushels natives, 160,000 bushels southern, besides what was operated by New York capital through agents who were citizens of New Jersey.

The steam dredge is used in waters over 3 fathoms deep.

There is a desire here to have the State enact laws with reference to the exportation of oysters of a size below a given standard, making it illegal to export seed, as in Delaware. This might give slight, though temporary relief, but let everything be done that can possibly be suggested, so long as the natural beds are public property they must not only continue depleted, but finally disappear, and the increasing supplies of seed needed must be obtained from other sources. For the present, the planting of shells by certain parties will give those parties enough seed, and possibly some to spare. Still, it is to be feared that by this method alone the price of seed will rise so as to drive out of business many planters, prevent others from entering business, and cause a smaller amount to be planted each year until the oyster product of New Jersey will not equal its present extent. Other States that have let out all the waters to private culture will supply the world's markets with the bulk of oysters consumed, and New Jersey will not keep in the front rank. In 1880 New Jersey ranked third in the amount of oysters produced, Maryland leading with 10,000,000 bushels, and Virginia coming next in order. The product in the South will gradually decrease, and, because of the great natural advantages, artificial cultivation will be long delayed. There is no reason why New Jersey should not, within a few years, if a wise, progressive course be pursued, step to the front in the rank of oyster production.

Give the oysterman privileges like those of the ordinary agriculturist, and his private interests will coincide with those of the community. If he finds it more profitable to export seed, the community will be benefited because he is benefited. Only under a system of restrictive legislation is it necessary to be continually regulating the industry.

*Shrewsbury River.*—I am indebted to Capt. Rhodes, of Red Bank, and George B. Snyder, of Fair Haven, for information here. The

North Shrewsbury or Navesink river is the principal seat of oyster-planting. The planters have comfortable homes on the banks of the river opposite their plantations. About 600 acres are under cultivation, held by about 15 planters, in lots of 10 to 100 acres each. Each day for 9 months from 30 to 125 barrels of oysters are shipped by rail, or an average of 50 barrels per day, at $5 per barrel. About as many go away by water, so that 70,000 bushels, worth over $100,000, may be regarded as the annual export. Ingersoll's estimate of $200,000 must be regarded as excessive.

Here the borer is the principal enemy. The clammers are also charged with foraging upon oyster-beds. In the upper part of the river in July a sort of "fermentation" of the bottom takes place, by which a poisonous scum is produced that kills the oyster. One planter at the head of the tidal area lost $10,000 worth through this cause, combined with the coming on of a freshet of water. This "fermentation" needs more careful study. It is probably not all due to simple decay of vegetation, though that in itself is a process due to the action of living germs, and thus a biological phenomenon.

*Barnegat.*—At this point I am indebted to L. G. Mitchell, George Hollingsworth and L. W. Bugby for information.

About 125 acres are under cultivation, but "there are thousands of acres of good ground unused." Much ground, especially that in the bay (for here the planters hug the shore), is not used, because there is a lack of current and an invasion of eel grass, which, in decaying, settles upon the oysters. The bay is quite shallow. The business has increased much of late, the newer planters planting more than their predecessors combined. Eight years ago the product was 8,000 bushels. Three years ago a Connecticut planter invested $75,000 in the business at this point, planted 14,000 bushels, and also laid down shells upon which he obtained a good set. This gave a stimulus to the business. The other planters extended their operations and laid down shells for spat with success. In fact, the spawn catches too well, and the old crop is in danger of being smothered and so can't be marketed before the new crop is ready. This is especially true of the Chesapeakes. Seed costs 40 cents a bushel. The product this year was below the average, but estimated on the number of acres the product should be 30,000 bushels.

*Manahawkin.*—Here I met Messrs. Jesse Wilkins and Throckmorton. There being no set on the natural beds, the scarcity of home seed compelled the use of foreign stock, which does not market so readily as the native. The business is thought to have doubled since 1880. The product is thus 10,000 bushels, requiring 50 acres.

The oysters this year were poor, though some found on the piles of the railroad bridge were extra good. Mr. Throckmorton experimented by planting brush, upon which spat fastened. When winter approached the decayed twigs were broken off at the level of low water, so the ice did not carry them off. The next year the oysters had dropped off and were found upon the bottom in rows where the brush had been. The decay of wood generally causes oysters to drop off, after having been fastened some time to it. The excellent condition of these oysters that grow up from the bottom is worthy of note. The minute life of the ocean is generally richest near the surface, except when inclement weather drives it down. This gives the oyster that is raised up from the bottom a chance at the food before it reaches the bottom. Besides, if the oyster could remain in its elevated position, at least through its younger stages, the danger of being smothered by mud is very much decreased. It has been found of advantage in planting shells to catch spat, to throw them in heaps. An enemy not so easily controlled is the decaying sea-weed, which causes a sulphurous or other distillation product, which kills the oyster and blackens the white paint on boats.

*West Creek.*—Here I met the station agent, who gave estimates of the export, and George Seaman, R. J. Rutter and Joseph P. Haywood furnished additional information. Four planters alone have 45,000 bushels of seed planted. This fall not many oysters were fit for market. Last season's shipment by rail was 27,000 bushels, said to be about one-half of all the oysters produced, many going away in boats to Atlantic City, &c.

The planted beds extend from Long Point on the north, to Edge Cove and opposite Barrel Island on the south, and include about 640 acres. About 300 bushels are planted to the acre and the same amount is expected as a product. "Nine-tenths" of this ground is also used for clamming.

More people are engaged in clamming than in oystering. About $500 per week, or $20,000 a year, is the income from this source.

Southern seed is used in part and does well. Cedar Creek seed yields four-fold. A black mussel sometimes invades the bay and is supposed to appear in great numbers whenever the oysters are poor, and so it is thought to eat the food the oyster lives on. This enemy can be turned to some account, as it is taken up by the wagon-load and sold as a fertilizer at $1 a load.

*Tuckerton.*—The following gentlemen furnished information at this point: C. A. Ireland, station agent; John T. Burton, James Speck, H. W. Sapp and Ed. Stites, oyster shippers and planters, and F. R. Austen, shipper of clams. This is the principal point in New Jersey from which clams are shipped, although only a portion of the clams produced in the waters in its vicinity are exported from Tuckerton. (See the section on the extent, &c., of the clamming industry.) From 200 to 500 men can be seen at one time in Great bay, taking clams. They complain much of the encroachments of the oyster planters on their grounds.

The planted oyster grounds cover about 125 acres. Two hundred bushels of seed are put upon an acre and 200 bushels of marketable oysters are expected. About as many oysters leave by water as by rail. The growth of oyster-planting has been rapid here, and the former pre-eminence of the clamming interests is now in danger of extinction. In 1887 there were 5,321 sacks and some few barrels of oysters exported by rail. In 1888, up to October 9th, 6,000 sacks of oysters had been shipped. From these data we may estimate the product to be about 30,000 bushels. There is a large export by water to Atlantic City. One person stated that he thought 20 clams were taken to one oyster, which by bushel measure equals ten times as many. Another more moderately put the clam product at four times that of the oysters at that point.

From here south into Cape May county oysters are not allowed to be taken up until a month later than elsewhere in the State. Mullica river seed (gravelings) is used, which requires longer to mature (because it is hard shelled) than the Cedar Creek seed. When shells are planted as spat collectors it is done in August. Small shells are preferred as not receiving so many blisters to a bunch. The oysters now down, that were ready for market, are badly blistered. When winter approaches oysters are transferred into deeper water, to put them out of the reach of the ice and cold.

*Absecon.*—The freight agent and Elmer Champion were consulted. During the three summer months 900 bushels per day are shipped by rail. The remainder of the year a half car-load of oysters and clams leaves daily. The yearly shipment may be put at 60,000 bushels, which represents at least 500 acres of cultivated ground. Clams are said to be worth only 30 cents, and oysters are more profitable. Southern seed used to be planted, but it was so apt to winter-kill that Mullica seed is now preferred. Eel grass is the great enemy, rendering most of the area of the bays unfit for use. The foraging of clammers upon the oyster-beds is complained of.

*Pleasantville and Lake's Bay.*—G. L. Cake, of the West Jersey station, and J. Price, of the Reading railroad freight offiee, and A. Fish, shipper of oysters and clams from Smith's Landing, were consulted.

The bulk of the shipment leaves the Reading station. About 70,000 bushels are shipped, mostly in the summer; 15,000 of these are raised in Lake's bay, where 300 acres are under cultivation. Nearly as much more yields clams, and the rest of the bay is invaded by eel grass, so as to be unfit for use.

*Somers Point.*—The station agent, W. H. Keates, was consulted. From 60,000 to 70,000 bushels of oysters are annually shipped, principally in sacks, in early summer and fall. The planting is mostly in the creeks, and Virginia seed is most in favor. Over 200 carloads have been planted the past season.

*Cape May County.*—This was not investigated as to its oyster production except from neighboring points. But little could be learned. The estimate of Ingersoll for 1879–80, of 60,000 bushels, will surely cover the extent of the industry at present. One-third of this is used by the hotels. Both Southern and native seed (of poor quality) are used.

*Maurice River Cove.*—The principal shipping point is at Long Reach, on the Maurice river, near Port Norris, a spur of the Jersey Southern road running thither. On the opposite side of the river at Maurice River station, is the terminus of a branch of the West Jersey road. At these points the packing-houses are closely crowded together, opening upon the river, with its fleet of oyster boats, on one side, and

upon the railroad tracks on the other. Twenty of the largest shippers were consulted individually. In 1880 there were 8 large planters operating 6,000 acres. Now there are over 20 operating 70 square miles. They plant now 8 miles from shore, in 24 feet of water, where the boats are exposed to heavy seas. Of the large area included, a large proportion is not in use. The old ground has been largely abandoned, as it was found that the oysters grew better on the new ground, farther out. Much of the bottom, too, is shifting and treacherous, so that, perhaps, not more than 10,000 acres may be considered as occupied by "plants."

The Collector of the port, Benjamin F. Campbell, has 385 vessels registered as engaged in taking up and planting oysters. About half belong to Port Norris people. Each has a capacity ranging from 150 to 300 baskets, and can fill this each working day from September 1st to January; 200 of them run to Philadelphia with oysters directly. There are more oysters now planted than ever before, and seed is scarce. The quality of the oysters here has not been universally as good, for some years back, as formerly, although some of the planters do not complain in this direction. In the lower part of the bay the borers are bad. A Baltimore company lost 60,000 bushels of seed by this pest one season. The stirring up of the bottom by waves and currents buries thousands of bushels.

The freight agent, W. S. Lambert, estimated that an average of 20 car-loads left daily during the season, sometimes rising to 40 car-loads, the capacity of a car being 100 sacks of 1,000 oysters each (nearly four bushels). Thirty-seven years ago only $3,000 was invested. Now one of the boats alone is worth $7,000. One year 20,220 sacks of oysters were sold from one dock (Captain Stites's).

Through the kindness of the editor, F. R. Fithian, I received a copy of the Bridgeton *Chronicle* for September 5th, 1888, from which I quote as follows: "There are now twenty-five prominent shippers and planters who own their own vessels and grounds and have invested over $3,000,000 in the industry, employing 430 vessels and 2,000 men. Last year they handled 280,000,000 oysters by actual count. These were shipped in 3,000 freight cars to all points in the Middle States, and some beyond, but principally to Philadelphia, New York, Trenton and Newark. These were worth at the wharves about $1,000,000. The oysters are all shipped in sacks averaging 1,000 to the sack."

A million bushels of oysters represent the average export by rail from Delaware bay, and to this we must add a quarter of a million bushels that are shipped to Philadelphia by water; but it must be borne in mind that the larger part of the latter is grown on the western side of the bay, where Jerseymen also do considerable planting, 312,000 bushels of Jersey seed being transferred to the Delaware side.

According to Capt. L. E. Yates, of Port Norris, only about 600,000 bushels (in round numbers) left Port Norris by rail during the last season (which has been an exceptionally poor one) and 80,000 bushels were shipped by water. One and a quarter million bushels of native Jersey seed were planted on the two sides of the bay. In our statistical table we have preferred to use the figures for a prosperous rather than for an exceptionally poor year, in order to obtain a fair idea of the value of oyster land.

According to Ingersoll, one and a half million bushels left Port Norris, mostly by water, in 1880. We see that as the railroad shipment has increased, the water export has correspondingly decreased. In 1880, it is also reported that two and a half million bushels of seed were planted, including southern stock. But now, according to Captain Yates, only about 15,000 bushels of southern stock are planted on the Jersey side.

The product the past season was not up to the average. The competition is very great and some of the planters fear bankruptcy. The seed is obtained in April and May, up to June 15th, by sail-boats operating dredges. Some contend that dredging benefits the beds by breaking up, cleaning and scattering the shells, and others, with good reasons, think the young oyster, with its tender shell, is injured so that a very large percentage of seed dies after planting, which consequently requires heavier seeding to be done and hence comes scarcity of seed. The great mortality of the seed is ascribed by some to a lack of observing the right time for planting it, either planting too early, when the weather is too cold, or too late, when it is too warm.

The oysters have failed of fatness, which some lay to overcrowding, and others to easterly weather driving in the clear and salter water and stirring up the bottom. It is surprising how the experience of 50 years, which some of these planters have had, has failed to make the planter acquainted with the nature of the product he is raising, so that each plant is considered a lottery, and if looked at as

an experiment, gives contradictory results. No one claims to be able beforehand to say that a given plant of seed upon a given bottom, will be successful or unsuccessful. Some boats have several grounds, so that if one venture fails others may retrieve the loss by being successful.

All boats pay a tax of 50 cents a ton to maintain a police-boat to watch the beds. This is not sufficient, however; some planters aver that they would willingly pay three times as much to be sure of protection. Here, as at Keyport, there is an Oystermen's Association, but there is a want of co-operative unity necessary to secure beneficial legislative action. One planter wants to be allowed to take up his oysters at any time, and another thinks this would increase the opportunities for stealing.

Delaware boats get seed on the Jersey side; and again, several Jerseymen plant in Delaware waters. The laws against these things can easily be evaded. There is complaint that seed is taken from the natural beds during the spawning months. Some desire to be allowed to get seed from the creeks. Others think that if no seed were allowed to leave the State that there would be seed enough. We have seen how small a fraction of seed actually does leave the State, so that, even if we retained this, when a slight increase in the amount of oysters planted, should occur, we would be as hard up for seed as ever. Under the present system, even if we had the best observance of the laws, and special legislation added to confer local benefits, by shelling beds, &c., there never can be a serious extension of business. If extension does occur it will be because, to a greater or less extent, shelling for spawn by the oystermen themselves has succeeded. But even this method is only a crude makeshift, and not scientific agriculture. Think of a florist setting out flower-pots near a plant with ripe seeds, that haply some seeds may fall upon his prepared soil and take root!

Those who have an abundance of seed planted, advise that the natural beds be allowed a two years' rest, so they may recuperate. If a bed is not very much depleted it can recover in one year; but a single year's operations would again leave it bare. If it be much depleted it may require ten or thirty years to restore it to its original condition, unless there be present many suitable objects as spat collectors.

*Summary.*—About 14,990 acres, or less, are under cultivation, yielding a product of 2,052,000 bushels, or that many dollars. Add-

ing the clamming industries, the revenue to the people from its molluscan fisheries amounts to two and a quarter million dollars annually. But the State receives not a cent of tax from the land-property which is held by planters in order to yield this income. A great future lies before oyster culture. Our waters are capable of yielding ten times as great a revenue to the people and a corresponding revenue to the State, if the industry be placed legally upon its proper footing, by the giving up of the tide-waters to the people to hold and cultivate as any other land, and paying the proper taxes thereon.

## 6.

### MEANS FOR IMPROVING THE OYSTER-CULTURAL INDUSTRY.

There are two great, pressing wants felt among oystermen, which, if not overcome in some way, will forever prevent any further growth of the business. One is the lack of seed and the other is the lack of ground which may be considered safe to plant on. Planting upon risky ground—ground which is liable to shift and to bury the oysters—is the main cause of the feeling among oystermen that the business is a lottery. There are other enemies that come in to help annoy and rob the planter, but if the planter could feel sure of his bottom he would be in a better condition to cope with secondary enemies. To a certain extent, there are practicable methods now in use looking to improvement in these directions. In Connecticut, which, with Rhode Island, leads America in progressive ostraculture, the raising of seed by planting shells is a successful and accomplished fact. That this method has its limitations, is crude and uses up a great deal of ground, must be clear, but it is the quickest way of solving a present difficulty, while theorists and scientists are slowly making their discoveries.

A great deal can be done to overcome the other difficulties. One Connecticut planter lost his oysters from the stirring up of the bottom, caused by storms, until he went out into deep water; he needed 40 feet of water to keep his oysters safe. That is deeper planting than is practiced in New Jersey. A muddy bottom, that is so soft as to allow the oysters to sink in it, has been converted into a bottom capable of bearing up an oyster by having 200 tons of beach sand per acre spread over it. In some cases, to keep off the sea, breakwaters need to be constructed. In case of our own Barnegat bay, it would be an

improvement to cut canals through the beach at different points, to increase the current.

We shall now turn to a consideration of the artificial raising of seed. In the seventh century, Sergius Orata is said to have practiced raising seed artificially, in enclosed brackish ponds. In later times these methods have been used in Fusaro lake, as follows:

Heaps of stones were made, upon which spawners were placed; a circle of stakes were driven around each heap and bundles of brushwood suspended between the stakes so as to catch all the spawn that was sent forth. When the East River seed raiser plants ten bushels of spawners to the acre, which has just been covered with shells, he acts on the same general principles but goes to work on a grander scale, yet with less artificial conditions. In France, specially-prepared tiles covered with a coat of whitewash and hydraulic cement, in alternate layers, have been suspended with the spawners or put upon oyster-beds; and the spat that attached itself could be peeled off. In 1879, Lieut. Winslow repeated these experiments successfully in Big Annemessex river.

In Europe, these experiments are usually conducted in enclosed ponds, into which sea-water enters only at the highest point of the tide. A sluice gate keeps back the water when the flow occurs. In 1879, Brooks discovered that the American oyster was bisexual, and thus he was enabled to fertilize the eggs artificially, by mixing the milt and roe. (The difference between these two fluids is not discernible except to the microscope.)

By this means we can control conditions so perfectly as to temperature and state of water, that we can insure the fertilization of every egg, which, in a state of nature, is left to chance. Thus, it becomes a possibility to rear millions of oysters from a single pair. We can guard and nourish the young embryo and give it objects of attachment. It is possible to conduct these experiments on a small scale, but with magnificent results. Seed for several acres can be generated in a small tank. This tank can be enclosed in a building with apparatus for maintaining a proper temperature, so that all the young are properly started on their career. It is even possible to experiment in the feeding of these embryos by introducing into the water different salts needed for the building of the shell. The field for experiment opens out grandly. We shall thus have oyster-hatching houses along our coast, from which any area can be stocked with seed, just as now the fresh-water ponds and brooks are stocked from the ordinary fish hatchery.

In 1883, John A. Ryder, of the United States Fish Commission, succeeded in raising spat from artificially-fertilized eggs. Following the French method, he had excavated out of a salt marsh near Stockton, Md., a small pond, which he stocked with the embryos that resulted from the mixture of milt and roe, and, by inserting tiles in this pond, he succeeded in collecting the spat and watching it grow.

Just as the ordinary fish hatchery has its ponds, so the oyster hatchery must have its ponds. The large extent of salt marsh of this State, over 200,000 acres, can be covered with ponds for the raising of seed. The ponds can easily be stocked, and each planter can have a pond near his planting grounds. It would be well to have two series of ponds, one series of small extent, which can be protected from sudden changes, and in which the early history of the blister is passed; then a series of ponds of at least three or four feet depth, and having a considerable area, into which the spat can be transferred to pass the winter. From these ponds seed one year old can be transferred to the planting grounds as ordinarily.

There remains but one hitch in all this beautiful arrangement—a difficulty which no one has succeeded as yet in overcoming. All these operations have been successfully carried out on both sides of the Atlantic, but the labor of rearing the spat, the expense of furnishing the collectors, and other incidental labors, have been so great that, compared with the method of shelling with intermixed spawners, it has cost many times more and yielded a crop of insignificant magnitude, because of the cost of the collectors.

A large portion of the country bordering the coast of New Jersey is so sandy as to raise nothing but stunted pines and cedars. To what use can these be put? Growing, as they do, in proximity to the oyster-beds, why should they not be used as spat collectors? Mr. Jesse Wilkins, of Manahawkin, informed me that the matter had come up in a conversation at Toms River, and that he had recommended cedar brush, as its bark was less likely to peel off. The thought now developed in my mind as follows: Cut the cedars and pines down, trim them, sharpen their butts, leave the coarser branches to stick out in all directions, for a certain distance, plant these bristling stakes in the mud, the deeper the water the longer the stake, and thus capture the spawn, as did the mustard-seed tree the fowls of the air, and so raise oysters as one would apples.

Certain things are evident. In the first place, the condition of the

bottom would not affect the oyster; it could not be buried either in sand or mud. In the second place, the number of oysters growing on each tree would be greater than what could be supported on the ground beneath the tree; and in the third place, the bottom would never become worn out. Thus it would require a much smaller area to raise a given quantity of oysters, and the oysterman could have his choice to get this, for he would not have to consider the bottom.

Tongs and dredges would have to give way to new machines, adapted to planting these trees and taking them up laden with oysters. Each planter could have his stamp or name upon his trees, by which they could always be recognized; and so he could claim his goods if he found them in possession of a thief. The deeper the water the taller the tree, the more oysters to the square yard of sea surface, so that there would be some compensation to the planter who would have to work out far from land.

This is the cultivation of oysters, no longer upon a surface, but vertically in relation to the depth of water, and hence the name *Bathymetric oyster culture.* Suppose it should be found that some or many of the oysters let go their hold through the decay of the wood, &c., then, of course, the bottom would be also covered with oysters, which could be dredged after the poles were pulled. But it is possible to treat wood so it won't decay, and it is also possible to make wicker-like cages at different heights upon these trees by binding the limbs together with grape vine, so that the falling oyster would be caught before it reached the ground. This is not a feasible plan, but it led to a feasible plan, in my mind.

Cut off all the branches on the tree and convert the trunk into a smooth stake. Next, get galvanized wire netting made into little crates. Dip these crates into a viscous paste made of clay and lime, gravel, &c. Bake it as tiles are burned and you have an excellent apparatus to which the spat will fasten. Use these as spat collectors in the oyster hatcheries. While the spat is small they can be pretty closely packed. As the spat grows the crates can be attached to stakes, which get longer and longer as the crates need to be placed further and further apart. As the stake increases in length, so should also the depth of the water, and so year by year the oysters march out to sea until they are marketable.

An *oyster grove* would then appear similar to, and need the same general kind of supervision as a vineyard. The trouble the vine grower has with boys who like grapes would find its parallel in that of the

planter who lies in wait for the oyster thief. So much for theory; the future is for experiments testing the theory.

The future is big with developments for this industry, which is so like ordinary agriculture, yet so far behind it in its progressive development. We should not be surprised to see the day when we shall talk of *breeds of oysters*, as now we do of hogs. A celebrated spawner may come to cost several hundred dollars. The wild boar is no more unlike the domestic hog of pure breed than our present oyster is like that of the future.

7.

STATISTICAL SUMMARY OF THE OYSTER INDUSTRY OF NEW JERSEY.

| LOCALITIES. | Area in Acres of Natural Beds. | No. of Bushels of Native Seed Planted or Produced, &c. | Area of Planted Grounds. | No. of Bushels of Oysters Marketed. |
|---|---|---|---|---|
| Newark Bay | 1,000 | 20,000* | ........ | ........ |
| Raritan River | 1,000 | 2,000* | ........ | ........ |
| Perth Amboy | ........ | 45,000 | 125 | 60,000 |
| Keyport | ........ | 200,000 | 1,600 | 262,000 |
| Shrewsbury | ........ | ........ | 600 | 100,000† |
| Barnegat | 13,000 | 15,000 | 125 | 20,000 |
| Manahawkin | ........ | 10,000 | 75 | 10,000 |
| West Creek | ........ | 50,000 | 640 | 60,000 |
| Tuckerton, &c | ........ | 15,000 | 125 | 30,000 |
| Mullica River | 4,000 | ........ | ........ | ........ |
| Absecon, &c | ........ | 60,000 | 500 | 60,000 |
| Pleasantville, &c | ........ | 15,000 | 600 | 70,000 |
| Somers Point, &c | ........ | 15,000 | 300 | 70,000 |
| Cape May County | ........ | 10,000 | 300 | 60,000 |
| Maurice River Cove and Delaware Bay | 60,000 | 1,250,000‡ | 10,000 | 1,250,000§ |
| Totals | 79,000 | 1,707,000‡ | 14,990 | 2,052,000‖ |
| Averages | About 20 bus. to acre, worth from $5 to $10. | | Nearly $140 income per acre ¶ | |
| Clams | Clams are produced by 100,000 acres, yielding an income of $2.00 per acre. By this and the oyster industry, at least 60,000 persons are supported. | | | |

* Includes only what is produced, that is not planted in State.
† Includes also South Shrewsbury.
‡ This estimate is below the average. It will be safe to place the yield of native oysters in the State at 2,000,000 bushels.
§ The yield for 1888 was less than two-thirds of this amount, but was exceptionally small.
‖ This may be read either as bushels or as dollars.
¶ The estimate of acres of planted ground is purposely taken as too large. The income usually expected is between $200 and $300 per acre.

The annual income to the people along the coast can be safely placed at two and a quarter million dollars, from both the oyster and the clam fisheries. The population of the townships bordering the beds and the planting grounds, excluding all north of Perth Amboy and all sea-side resorts, is 62,389. All of these are not engaged directly in these fisheries, but they depend upon them for support, the presence of the capital, and the earnings of those who are engaged in the business.

The figures in the above table are only *estimates*, it being well-nigh impossible to obtain data that could be considered as accurate. The method by which they were obtained is discussed in separate sections and paragraphs of the report.

The gathering of these statistics was not the chief aim of the Biologist, but rather by this means to lead up to higher experimental work upon which progress in oyster and fish culture of the future so largely depends. The writer believes that all who are interested in oyster culture should labor to make this industry resemble farming as far as possible. He asks and confidently expects the hearty co-operation of intelligent persons interested in the business, in undertaking practical and theoretical investigations, seeking a better knowledge of the laws of life, growth and reproduction of oysters and other food fish, their enemies and their food.

JULIUS NELSON.

# REPORT OF THE ENTOMOLOGIST.

A Department of Entomology was determined upon early in the season of 1888 and an Entomologist appointed.

The design of the department is in the main, first, to ascertain the habits and history of insects, that the best means may be found for preventing the ravages of those that are destructive and for preserving those that are beneficial, and second, to establish a museum where the insects of the State, in their various stages of development, may be seen and the methods of their work and its results be exhibited.

To the most of people insects are but vermin, sometimes appearing in such numbers as to be temporarily destructive, but not considered of sufficient importance to be worthy of serious study; indeed, an interest in them is by many judged to be evidence of a depraved taste, if not an evidence that the one interested is mentally a little "off." We will, therefore, be pardoned if we speak a few words at this time showing the economic importance of their study in view of the destruction caused by them.

It is probable that the injury done by insects is very much less felt in New Jersey than in any other State in the Union. New Jersey has very considerable variation in the character of its soil and there is a very considerable variation in the altitude of its surface above the sea; because of these it is hardly possible that the State can suffer universally from any insect pests. Apart from these, however, there is perhaps no other State which has so great a variety of generally-cultivated products, or in which the cultivation of the soil is so close and continuous. Being, to a great extent, the kitchen garden of New York and Philadelphia, a large part of the time and work of its agriculturists is given to truck farming, and as a necessity the products are varied, follow one another rapidly, and constant cultivation of the soil is required. A succession of the same crop year after year and a comparatively little cultivation of the soil are both favorable to the development of insect life, and the methods and require-

ments of truck farming are an unintended but constant battle against insect pests. It is hardly possible, therefore, that New Jersey can experience any such general evil as more or less constantly comes to many other States through the ravages of the Hessian fly, the chinch bug, the cotton worm and the Rocky Mountain locust. Our farmers and gardeners are rarely dependent upon one or very few products, and whatever losses may come through insect agency, there is never a loss which is entire.

But while all this is true, insects are neither exterminated nor inactive in our State, and the loss by their agency is probably much greater than the most of people realize. I have not the data as yet upon which to base even an approximate estimate, but from what I have learned I am quite confident that the money loss to the State through the agency of insects is equal to all losses by all other natural agencies of destruction combined, disease only excepted. In certain staple crops the annual loss is not less than hundreds of thousands of dollars. I am led to believe, for example, that the cranberry crop is not half what it would be if it were not for the injuries directly or indirectly caused by the web, fire and tip worms. In the vicinity of New York many gardeners have entirely given up the endeavor to raise early cauliflower, owing to the destruction caused by the root worm, and late cabbages on account of the ravages of the caterpillar of the cabbage butterfly, among other causes. The apple crop is pretty largely a failure by reason of the codling moth, and hardly an attempt is made to raise plums, on account of the curculio.

Besides these and other evils a means of loss every year over nearly or quite all of the State, there are every year losses more or less local, but whose aggregate is by no means small. The army worm, wire worms, cut worms, rose and grape beetles, the peach and apple borers, are pretty sure to show themselves as very destructive somewhere. We think, therefore, our estimate under, rather than above the truth.

It is unfortunately true, for various reasons, that many of these insects are not under the control of any agencies man may bring to bear upon them, and as a consequence little or nothing can be done against their ravages. But it is as well true that a very great deal of injury may be averted by the watchful energetic farmer. There is no greater insect pest than the Colorado potato beetle. If nothing were done against it, I have no doubt not a potato would be raised in this State. But as all know, it is easily kept under control. So, very many of our insects may be just as easily guarded against.

During the season of 1888 special research and experiments were made upon "the insects injurious to cabbage and the best means of preventing their ravages." The results were published in a special bulletin (No. 50) of the Experiment Station, which has been distributed throughout the State and which may be had at the Experiment Station, and to this we call special attention.

A number of other insects have been reported as injurious in various parts of the State, the grape in the southern part of the State seeming to have come in for more than its share.

The greater portion of inquiry, however, has been made with regard to certain insects which have proved to be especially destructive to shade trees in our cities and villages. Of one or more of these the various State Entomologists have given detailed histories and have published information as to the best methods of destruction; also, a special bulletin upon the subject was issued by the Department of Agriculture, in which the most complete information was given. We give a summary of the history and point out remedies of a few of the worst of these. Those which are the most injurious in New Jersey are the white-marked tussock moth (*Orgyia leucostigma*, A. & S.), the bag worm (*Thyridopteryx ephemeræformis*, Haw.), the elm-leaf beetle (*Galeruca xanthomelæna*, Schrank), and the cottony maple scale louse (*Pulvinaria innumerabilis*, Rathvon). Of these we will give only a very brief outline of history and methods of destruction.

### THE WHITE-MARKED TUSSOCK MOTH.

(*Orgyia leucostigma*, A. & S.)

The caterpillar of this moth is an almost universal feeder. It has something of a preference for the horse-chestnut, but in our gardens freely devours the leaves of apple, pear and quince trees. We have seen a number of these trees, the leaves of which were almost entirely destroyed. In our latitude the insect is only in part two-brooded, the great majority of the eggs laid by the first brood remaining unhatched until the following spring. The male is a small moth with broad, dark ashen wings, with a somewhat conspicuous white mark on each fore wing. The female is entirely wingless, and, emerging from the cocoon, rarely leaves its outside. The eggs are laid in a mass on the outside of the cocoon from which the female emerges, and, as laid, are

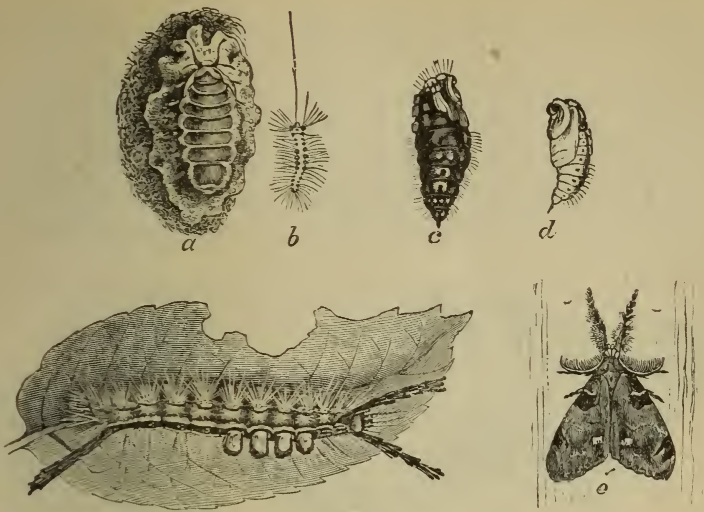



Fig. 1.

THE WHITE-MARKED TUSSOCK MOTH; *Orgyia leucostigma*, A. & S.
*a*, female on cocoon; *b*, young larva; *c*, pupa, female; *d*, pupa, male; *e*, moth, male; *unlettered figure*, larva full grown.—(After U. S. Department of Agriculture.)

covered with a white, frothy substance, which soon hardens; the whole mass forms a conspicuous object.

The caterpillars, with their tufts of hairs (black, yellow and coral red), are most beautiful objects. The English sparrow never touches them, and the birds that do—the robin, cuckoo and oriole—are not suffered to live by the street gamin with his "bean-shooter," and the so-called "hunters" who pour out of our cities on Sundays and holidays; and all this in contempt and defiance of law. The caterpillars are troubled to a comparatively little extent by parasites, though we have known whole masses of eggs to be thus destroyed. But altogether the insects have multiplied until they have become a very great pest. Becoming full grown, the caterpillars make a loose cocoon of the hairs which cover their bodies, locating it between leaves on the trees, but generally in cracks of the bark, in convenient tree boxes, and along fences and buildings.

## REMEDIES.

In the winter-time it is easy to collect and destroy the greater portion of the egg masses. We would advise, however, what would be

very much better, namely, collect them, and, without destroying, remove them to some raft or float entirely surrounded with water and leave them till the following summer. The caterpillars hatching would starve and die, but the parasites hatching and having the power of flight would be spared to destroy the eggs of those that had not been collected, and thus so decidedly add to the work of destroying the insects that it might be years before they would again assume the form of a pest.

As is the case with all leaf-eating caterpillars, they can be easily destroyed by spraying the infested trees with arsenical poisons.

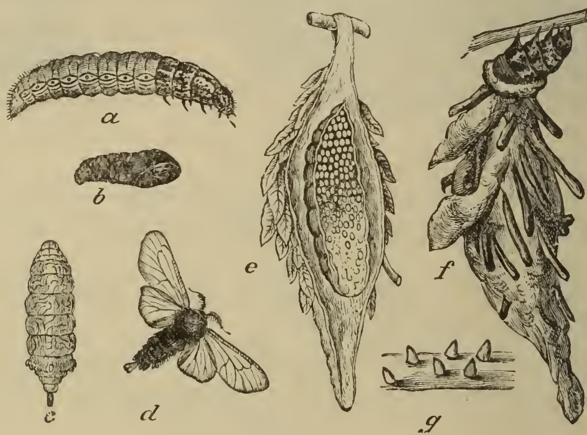



Fig. 2.

THE BAG WORM.

(*Thyridopteryx ephemeræformis*, Haw )

*a*, larva; *b*, pupa, male; *c*, moth, female; *d*, moth, male; *e*, bag cut open to show eggs; *f*, full-grown larva with bag; *g*, young larvæ with conical coverings.—(After U. S. Department of Agriculture.)

This insect, in the caterpillar state, lives in a bag composed of bits of leaves bound together with a mass of silk. It is an almost universal feeder, rather preferring cedar and arbor vitæ, though seemingly fond of Norway and silver maple. It is single-brooded and the moths appear in early September.

The male is blackish, having wings for the most part transparent. The female is wingless, grub-like, and never leaves its basket. The sexes mate, and the fertilized eggs remain within the basket which held the female, till the following spring.

REMEDIES.

These are the same as for the white-marked tussock moth. The baskets are to be collected in winter, when they can very easily be seen hanging to the twigs at the extremity of the limbs of the tree or shrub. While eating, the caterpillars can be easily destroyed by spraying the food plant with arsenical poisons.


Fig. 3.

THE IMPORTED ELM-LEAF BEETLE.

(*Galleruca xanthomelœna*, Schrank.)

*a*, eggs; *b*, larvæ; *c*, adult; *e*, eggs (enlarged); *f*, sculpture of eggs; *g*, larva (enlarged); *h*, side view of greatly enlarged segment of larva; *i*, dorsal view of same; *j*, pupa (enlarged); *k*, beetle (enlarged); *l*, portion of wing cover of beetle (greatly enlarged).—(After U. S. Department of Entomology.)

This beetle has, during the last few years, become a very decided pest, probably in great part through the destruction of insect-eating birds, which would serve to keep it in check.

The beetles hibernate in places which give them convenient dry

cover, and emerge from the sleep of winter as the leaves of the elm begin to unfold. The period of the life in the beetle state is considerably extended, in the hibernating brood, reaching at New Brunswick nearly to the end of June in many cases, and in midsummer extending over two or three weeks. During this time they eat the leaves of the elm, cutting round holes generally about one-quarter of an inch in diameter. Thus, in the perfect state they do a great deal of mischief, and help, through the punctured leaves, to give an unsightly appearance to the trees.

The eggs were found quite plentifully at the beginning of June, and the beetles were yet busy laying during the third week in June. The eggs are conical, orange-yellow in color, laid on the underside of the leaves in masses side by side, and in number from three to twenty in each mass. Those observed hatched in six days. They became full-grown and descended the trees for pupating, which is done just below the surface of the ground, about the middle of July. They remained in the pupal state two weeks. Supposing these to have hatched from the eggs earliest laid, from six to eight weeks would be required for them to pass through all their history. At New Brunswick and on Long Island there are two broods only.

Owing to the fact that the elm is one of our largest shade trees, the destruction of the beetle would seem to be a matter of very great difficulty. The trees in the college campus at New Brunswick are very good examples of their kind, being perhaps, in some cases, over seventy-five feet in height, yet there was no great difficulty in saving their foliage from destruction. A good force pump was procured; the one obtained was with a tank holding forty gallons attached, and a barrow attachment also, so it could be easily moved from tree to tree. Any amount of power could be put behind the liquid by the pump. How this machine may compare with others we cannot say, but it answered our purpose admirably and we could wish for none better. It was made by the Gould Manufacturing Co., of Seneca Falls, N. Y. A hose, one-half inch in diameter and over fifty feet in length, was attached to the pump; on the other end was secured a fine rose nozzle, for spraying, and just below the nozzle the hose was lashed to a jointed bamboo pole, eighteen feet long, the whole length of the pole. The grub of the beetle eats the underside of the leaf, rarely, if ever, cutting through it. It is necessary, therefore, that the poison should be placed upon the underside of the leaves.

To effect this a light twenty-eight-foot ladder was placed against the main branches in the interior of the tree, and from its top, by means of the long bamboo pole, the poison was directed and sprayed underneath the leaves on the higher parts of the trees. The lower branches, to a height of twenty-five or thirty feet, were better sprayed from the ground, the pole being disjointed for easy use on those very low. Of course, the spraying could not be complete, but no tree sprayed was more than slightly disfigured, while two in the middle of the rest, and unsprayed, were almost entirely defoliated.

The poison mostly used was one-half pound London purple to fifty gallons of water, with three pounds of flour added. Experiments were also made with pyrethrum-water, kerosene emulsion, and with these mixed together. We would recommend the use of a compound of London purple and the kerosene emulsion as the most effective. It is very important to keep the London purple solution well stirred, since, if it become somewhat thick—that is, over an average of one pound to fifty gallons of water—the leaves of the tree will be burned, and the remedy may be as bad as the disease.

As has been said, the grubs descend to the ground to pupate. Those that are not destroyed by the poison may be easily trapped in their descent with a coating of tar about the trunk of the tree, or by closely-fitting boxes containing tar or some other substance which they cannot pass.

### THE COTTONY SCALE LOUSE.

(*Pulvinaria innumerabilis*, Rathvon.)

We are not able to give anything concerning this insect based upon personal experiment. It is very common in Newark and Jersey City, as also in Brooklyn, L. I. The most effectual remedy is the kerosene emulsion. The leaves, limbs and trunk of the tree must be thoroughly saturated. The best time is in early Summer, after cutting back the tree the Winter previous.

We also call brief attention to a few of the worst of our fruit-destroying insects.


**Fig. 4.**

THE COTTONY SCALE LOUSE; *Pulvinaria innumerabilis*, Rathvon.

*a*, leaf with male scales—natural size; *b*, single male scale; *c*, male—enlarged.—(After Forbes.)

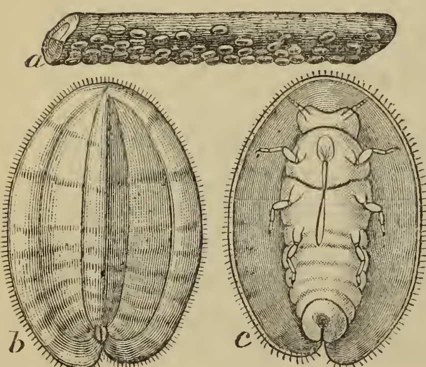



**Fig. 5.**

THE COTTONY SCALE LOUSE;
*Pulvinaria innumerabilis*, Rathvon.

*a*, female scales in Autumn; *b*, view from above; *c*, view from below—enlarged.—(After U. S. Department of Agriculture.)


**Fig. 6.**

THE COTTONY SCALE LOUSE;
*Pulvinaria innumerabilis*, Rathvon.

*a*, females with egg masses in late Spring on Maple leaf; *b*, the same on stem of *maclura*.—(After Riley.)

### THE CODLING MOTH

(*Carpocapsa pomonella*, Linn.),

AND THE

### PLUM CURCULIO

(*Conotrachelus nenuphar*, Herbst.)

It has been repeatedly proved during the last few years, by experiments carefully conducted by entomologists, especially those of the Western States, that a very large percentage of the apple and plum crops can be saved from the ravages of these insects by the use, at the proper time, of arsenical poisons.

The trees should be sprayed, and the fruit at least, thoroughly saturated with a solution of London purple, about one-half pound of purple to fifty gallons of water. This should be done just after the falling of the blossom of the apple or plum, and should be repeated after ten or twelve days. This will save the bulk of the fruit from becoming wormy.

### THE ROSE BEETLE.

(*Macrodactylus subspinosus*, Fabr )

This beetle has become a great pest in the southern part of the State, very seriously injuring many fruits, and especially proving damaging to the grape. We have had no personal experience with it at New Brunswick. The egg, grub and pupal stages are passed beneath the surface of the ground, and, as a consequence, all destructive agencies must be used against the perfect beetle.

Prof. A. J. Cook, of Michigan, recommends the use of pure pyrethrum powder. This would have to be repeated every day or two. Prof. C. V. Riley, of Washington, says the use of Bordeaux-water has served as a preventive.

In conclusion, we would urge upon our farmers and gardeners the extreme importance of keeping a continual watch for the first appearance of any injury done to their trees or crops by insects. As a rule, the life of an insect in its larval stage is very short, and measures for destruction can never be safely delayed. All insects, as a rule, can be more easily destroyed when very young than at any later development,

and not a few can be successfully combated at no other time. It is easier, and, in the long run, much cheaper to use preventives, that the insect may be destroyed as soon as it appears, if it does appear, than to wait till its ravages are seen and more or less injury has been and must be the result.

It is the desire of the Entomologist to form, in connection with the Station at New Brunswick, a museum giving, first, a systematic collection of all insects found in the State of New Jersey, and, second, a collection of noxious insects in all stages of development, with specimens showing their methods of doing injury, and also specimens of insects parasitic upon them. With this in view, he solicits for this purpose donations of duplicate or other material from all collectors. Any or all donations will be gratefully received and acknowledged.

GEORGE D. HULST.

# REPORT OF THE CHEMICAL GEOLOGIST.

## ON THE INVESTIGATION OF SOILS.

As the State Experiment Station has decided to add to the work previously pursued an investigation of the soils of the State, it seems advisable at this time to indicate preliminarily and briefly the scope of soil investigation in the past, and finally some of the reasons which make it desirable to assume this undertaking.

*The Beginning of Soil Investigation.*—During the first part of this century, while the applications of science were producing profound revolutions in the world's varied industries, it seems to have been the almost, if not quite, universal belief, that the soil of the earth was peculiarly and exclusively the property of the farmer. Whatever may have been, from the scientist's point of view, the desirability of a scientific encroachment on these vested prerogatives of the tiller of the soil, to the farmer, at least, such an undertaking would have appeared a useless waste of labor and time; for whatever may have been considered to be the qualifications necessary to the successful pursuit of other trades, to the mind of the cultivator of the soil of that day, the only knowledge of any advantage to himself was that obtained by a little practical experience behind the plow.

It is to Liebig that the scientist, as well as the practical farmer, is indebted for the removal of this indifference to the study of soils. Exact methods in soil investigation date from the beginning of the forties, when he clearly showed that the plants obtain their nourishment from the soil and the air, and that vegetation can exist only where the soil contains the ash ingredients of the plants.

Encouraged by so competent a leader as Liebig, the investigation of soils soon became a popular field of work for a constantly-increasing number of chemists, especially among the Germans, his fellow-countrymen.

But though the above-quoted conclusion of Liebig was subsequently abundantly verified, it soon became apparent that mere chemical analysis does not suffice to furnish a reliable index of the fertility of a soil; that there are other conditions beyond the scope of ordinary chemical inquiry, which powerfully affect the productive capacity of a soil. Scientific experiment had thus far not advanced very far beyond the standpoint of the practical agriculturalist; it had merely reiterated his experience in a more scientific phraseology, viz., that it is not always the soil which contains the greatest absolute amount of plant-sustaining matter that is capable of supporting the most luxuriant vegetable growth. The farmer's experience had taught him that the two physical soil extremes, sand and clay, no matter how thoroughly they are manured, are neither of them fitted, the one on account of its excessive dryness, the other on account of its heaviness and the resistance which it offers to the growing rootlets, to the purposes of agriculture; whereas a loamy soil, a happy mixture of the two, is prized as possessing most of the advantageous, and few of the disadvantageous properties of both.

Most soils, including the best, consist, physically speaking, of a relatively small amount of clayey matter, intermixed with a largely preponderating mass of sand. The latter, made up of almost pure quartz, can manifestly contain little or no plant-nourishment, and its function is merely that of a skeleton, rendering the soil light and porous, and pervious to air and water.

*Mechanical Soil Analysis.*—For the purpose, therefore, of gaining an insight into the mechanical subdivision of the soil ingredients, and with the hope of thus throwing some light on one of the most potent conditions controlling the growth of crops, there was rapidly developed the so-called mechanical soil analysis—that is, the mechanical separation of the soil into several conventionally-chosen grades of fineness. After the coarser grades have been removed by means of graded sieves, the fine sand, together with the clay, is subdivided and separated by the process of elutriation. This process is based upon the principle that, if miscellaneous material of the same or approximately the same specific gravity be allowed to fall through water, the coarser particles sinking faster will accumulate at the bottom, the less and less coarse succeeding, while the very finest will be deposited last.

All elutriators, of which a large number have been devised, may be

divided into two classes. In the first and simplest class, of which the apparatus designed by Prof. Knop (Knop, Bonitirung der Ackererde 2 Auf. 50, 51. See, also, "Tobacco Soils," by Dr. Moore, 10th U. S. Census, Vol. III., pp. 872, 873) is perhaps the best representative, the material is allowed to settle a definite length of time, when the water, together with the still-suspended particles, is either decanted or drawn off. By repetitions of this process, and by varying the time of settling, the desired number of separations can be made with approximate accuracy, though at the cost of considerable time and labor.

In the second class of elutriators, which are designed to run more or less automatically, the material is carried along by a regulated current of water. By graduating the current successively to definite, known velocities, it is possible to subdivide the fine earth into grades of the required diameters, or more exactly, of known hydraulic values.

Of these elutriators the instrument invented and first described by Schöne (Zeitschrift f. Analytische Chemie, 7, 1868, p. 29), as later modified by Orth (Bericht d. D. Ch. Gesellschaft XIV., p. 3026), seems to have met with quite general acceptance among the Germans.

In the United States, where the subject of soil investigation has as yet found fewer votaries, Prof. Hilgard has carried on extensive investigations, and has perfected his "churn elutriator" (Am. Jour. Sci., Oct. and Nov., 1873), in which he has succeeded in replacing the generally-used conical vessels with a cylindrical tube, having first clearly shown that the employment of conical vessels inevitably gives rise to gross inaccuracies, when used to separate very fine or clayey soils.

Quite recently this branch of soil analysis has received an able and thorough overhauling by Dr. T. B. Osborne, at the Connecticut Agricultural Experiment Station. (See Report of Conn. Agr. Ex. St. for 1886 and 1887.)

In his critical review of the best and most widely-employed methods of mechanical soil analysis, he not only confirms Prof. Hilgard's conclusions as to the effect of conical vessels, but has also pointed out the erroneous and misleading results obtained by previously boiling the soils, "because it not only abrades and reduces the coarser sediments, but dehydrates and coagulates the true clay, and thus essentially alters the texture and grain of the soil." At the same time, the apparently well-founded objection is made to the churning process of

Prof. Hilgard, that the constant and long-continued trituration of the soil particles does materially influence the results by unduly increasing the percentage of clay and finest silt, at the expense of the coarser sediments.

Not content with mere destructive criticism, Dr. Osborne has given us in his so-named "beaker elutriation," a most excellent method for the mechanical analysis of soils. He has shown that by a simple process of repeated decantations from beakers, controlled by microscopic examination of the sediments and assisted by occasional pestling of the partially-separated sediments, it is entirely possible to make sharper separations than by any other known method, thereby avoiding the inaccuracies incident to boiling and churning, and that, too, with an outlay of time and labor no greater than is required for hydraulic elutriation.

Without dwelling longer on the merits of elutriation methods we would add, that having enjoyed an opportunity during the previous summer to test the "beaker elutriation" method under the kind direction of Dr. Osborne, we were thoroughly convinced of the advantages claimed for this system, and of the ease with which skill in the manipulation of the beakers is acquired and satisfactory results are attained.

*Physical Soil Analysis.*—Soon after the application of these mechanical methods to the analysis of soils, the physical properties of soils became the object of more thorough examination. Their behavior towards liquids and gases, and the influence of changes of temperature, &c., became subjects of repeated and prolonged experimentation.

The investigation of these laws which exert such an important influence upon the fertility of a soil, has taxed the patience and ingenuity of scores of well-equipped experimenters, and the most valuable results have been obtained only after long years of tedious painstaking research. To illustrate the great advantage that may accrue to the science of agriculture by these researches, the valuable and remarkable papers "On the Power of Soils to Absorb Manure," by J. Thomas Way, (Jour. Royal Agr. Soc., Vol. II., 1850, pp. 313–379, and Vol. XIII., 1852) may be cited. Among many other and important conclusions which were the outcome of these papers, those of greatest value to the farmer may be summed up as follows: Soils, owing to the presence of clay, have the power to absorb from solutions the very substances

that are of the most value to the crops, namely, ammonia, potash and phosphoric acid. As far as ammonia is concerned it makes no difference which salt is used, as the salt is decomposed and the ammonia fixed in the soil. A good soil is capable of retaining sixty times as much ammonia as is necessary at any one manuring, but being once fixed it cannot be readily distributed by water, hence the desirability of distributing the manure as evenly as possible. For this reason the advantage of liquid manure is apparent. On the other hand, sandy soils, containing but little clay, are not capable of fixing the valuable salts, whence the desirability of manuring such soils often and lightly, in order to prevent waste.

Whether this action of the soil in fixing these important substances, in apparent defiance of known chemical laws, is due to the chemical affinities of certain alumo silicates, as suggested by Mr. Way in his second paper, or whether they are simply physically attached to the soil, as Liebig seems to have held (Liebig, Die Chemie in ihrer Anwendung auf Agr. u. Physiologie, Bd. II., S. 74) is a matter of conjecture; the value of the results obtained are of equal value to the agriculturalist in either case.

Though it has long been recognized that neither chemical, mechanical nor physical soil analysis, nor all three combined, can give an exact measure of the fertility of a soil, still they may often be of the greatest value in specific cases, as for instance, when sterility is caused by the presence of some deleterious substance of either organic or mineral origin, or when the physical conditions are not favorable to the growth of crops. By the aid of these investigations the farmer may often learn the cause of the unfruitfulness of his field and be enabled to apply the proper remedy, and in many other respects the soil analysis may provide data of the utmost consequence, which the farmer unaided could never know.

As an illustration of the important conclusions that may be legitimately drawn from a careful chemical soil analysis, we will cite a few of the analyses made under the auspices of the State Geological Survey and published in the report for 1879:

| | Potash. Pounds. | Lime. Pounds. | Phosphoric Acid. Pounds. |
|---|---|---|---|
| I. Natural Soil, woodland, Chester, Morris County...... | 1,393 | 5,226 | 4,006 |
| II. Soil, Virgin, Robert I. Smith, Bloomsbury, Warren County ........ | 8,187 | 5,731 | 2,787 |
| 41. Soil, Natural, east of Whiting's, Ocean County........ | 431 | 120 | 431 |

In order to interpret these figures into a language more intelligible to a farmer, let us compare them with the total amount of mineral matters taken from an acre of soil in a five years' rotation of the following crops: 1, red clover; 2, red clover; 3, Indian corn and corn stalks; 4, Irish potatoes and potato tops; 5, wheat and wheat straw, as given on page 43 of the annual report of the State Geologist for the year 1878:

| | | |
|---|---|---|
| Pounds of Potash | 581 | Total, five years' rotation. |
| Pounds of Lime | 259 | |
| Pounds of Phosphoric Acid | 179 | |

Taking for granted, then, that the above three analyses represent all the available nourishing matter of a mineral nature that these soils contain, the third or poorest soil (No. 41) does not contain potash enough to suffice the five years' rotation of crops, as, at the above indicated rate of consumption, all the potash would be exhausted at the expiration of a little over three and one-half years. Similarly, for the same soil, the lime would last about two and one-third, and the phosphoric acid twelve years.

On the other hand, soil No. 1 would appear to contain the necessary potash for twelve years, lime for 107 and phosphoric acid for 112 years' cultivation. For soil No. 2 the corresponding figures are, for potash sixty-two years, for lime 110 years and for phosphoric acid seventy-eight years.

It is quite manifest from these analyses, that the farmer can expect to get from the poorest of these soils only what he puts into it in the form of fertilizers, whereas the other two, especially the soil from Bloomsbury, hold in reserve a large store of plant-food, which can only be exhausted after many years, possibly scores of years, of incessant tillage, without receiving any accessions whatever.

*Prospects of Soil Investigation.*—Considering the great amount of knowledge that has been already attained in the investigation of soils, and encouraged by the rapid progress of the last score of years, there is good reason to hope that the further pursuit of the subject will continue to yield results of the greatest importance, both to science and to agriculture.

*Reasons for Encouragement of Soil Investigation in the United States.*—In a paper on the "Objects and Interpretation of Soil Analy-

ses," published in the American Journal of Science for 1881, Prof. Hilgard refers to "two chief factors that have contributed to bringing soil analyses into disrepute in Europe: one is, the fact that virgin soils are there practically non-existent, nearly all the soils analyzed having been at some time subjected to cultivation, and, concurrently, to the use of manure, thus veiling their original characteristics and rendering extremely difficult, to say the least, the taking of any sample of soil that shall correctly represent the whole of a large field or district. The second is, the absence of systematic investigation of the subject since the time of the introduction of the most essential improvements in the determination of some of the chiefly important mineral soil ingredients." In the subsequent plea he makes for the continuation of soil analysis, he urges, and justly, the exceptional conditions still existing in the United States, where virgin soils that have never seen the plow are very common, and from which, if anywhere, concordant results may be expected. In his study of the soils of Mississippi, Prof. Hilgard finds these expectations fully realized. "The first question arising in this particular connection," says he, referring to the interpretation of the results of soil analyses to the farmer, "is naturally, whether all soils, having what experience proves to be high percentages of plant-food when analyzed by the processes above given, show a high degree of productiveness. So far as my experience goes, this question can, for virgin soils, be unqualifiedly answered in the affirmative; provided only, that improper physical conditions do not interfere with the welfare of the plant."

Virgin soils, however, are by no means confined to the West and South, but even in the Eastern States, and in particular in New Jersey, there are many regions that have never been cultivated, and where the principles laid down by Prof. Hilgard for the study of the soils of the West may with great advantage be applied.

Heretofore we have been dealing with soil from the standpoint of the agriculturalist alone, who defines a soil as "the uppermost loose and in part earthy layer of the earth's crust, in so far as the same is able to support a vegetation, no matter how scanty."

It is evident, however, that as soon as we enter upon the discussion of the origin of a soil, we immediately leave the domain of agriculture and join hands with the geologist. The geologist as well as the agriculturalist lays claim to the soil as belonging peculiarly to his realm of investigation, for he it is that brings down the genealogy of

the soil from its genesis to the present time. It is right, then, and desirable that both should labor together for the common good.

*Origin of Soils.*—It is evident to a very casual observer that the soil, the uppermost layer of the earth, is rarely entirely independent, as to its nature, from the underlying material of the earth. In the vast majority of cases it has been derived from that underlying material by the process of weathering—that is, through the influence of heat and cold, and through the chemical activity of air and percolating water. A knowledge, therefore, of the subjacent rocks from which our soils have been derived, and of the chemical and physical forces that have first caused the disintegration of the solid rock, then gradually converted the debris into a fruitful soil, is of the first importance to the soil investigator.

It is a matter of congratulation to learn that the United States Geological Survey is turning its earnest attention to preparing soil maps in addition to ordinary geological maps of the districts under survey. In his report for the last fiscal year the Director of the survey, Major Powell, has presented a tentative classification of soils, grouping them under two general heads, as follows:

"*Endogenous Soils* are those derived from the country rocks, and remaining in place."

"*Exogenous Soils* are those derived from other sources than the country rocks proper to the district where the several soils are situated."

These two groups of soils are well represented in the State of New Jersey. North of a line running in irregular course across the State from Perth Amboy to Belvidere, the country rock is deeply buried by the glacial drift, which has been scraped together far to the north and dumped down here in promiscuous confusion. The soils in this part of the State naturally partake of the heterogeneous nature of the drift from which they are derived.

To the south of the afore-mentioned line the soils belong mostly to the "endogenous soils," and here it is where the most important results are to be looked for. In this respect New Jersey has a great advantage over the more northerly-situated drift-covered States.

The Geological Survey of the State of New Jersey has already

made a good start in the investigation of the soils of the State. The annual report of the State Geologist for the year 1878 contains a "Preliminary description and classification of the soils of New Jersey," in which they are divided, according to their origin, into the following kinds, viz.:

| | |
|---|---|
| Granitic soils, | Clay-district soils, |
| Limestone soils, | Drift soils, |
| Slate soils, | Marl-region soils, |
| Red sandstone and shale soils, | Tertiary soils, |
| Trap-rock soils, | Alluvial soils. |

The geological formations of the southern and eastern portion of the State, which consist of sands, gravels and clays, are themselves the debris swept together from pre-existing rock-masses, and have already undergone, either before or during their transportation, that disintegration and decay which must necessarily precede the formation of soil. In order, therefore, to study the whole process of soil formation, we must seek the more northern portions of the driftless area, where the solid country-rock comes to the surface. Such soils are the red sandstone, shale, trap-rock and the granitic soils, which are homogeneous in texture and composition over extensive areas. Here, too, we may find the condition, indicated by Hilgard, of successful soil analysis fulfilled, viz., a virgin soil, untouched by the plow and unacquainted with manure.

As no universally-acceptable classification of soils has as yet been proposed by soil investigators, the above-given natural and simple classification, chosen with special reference to the soils of this State, presents a strong claim for recognition, and will, for the present at least, with such amplifications as future investigations shall make necessary, be adopted by the State Agricultural Experiment Station.

H. B. PATTON.

# APPENDIX.

## ACT OF INCORPORATION.

The New Jersey Agricultural Experiment Station was established by authority of the following acts of the Legislature of the State:

### CHAPTER CVI.

AN ACT TO PROVIDE FOR THE ESTABLISHMENT OF AN AGRICULTURAL EXPERIMENT STATION.

1. BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey,* That for the benefit of practical and scientific agriculture, and for the development of our unimproved lands, the New Jersey Agricultural Experiment Station, with suitable branches, is hereby established.

2. *And be it enacted,* That the direction and management of this institution shall be committed to a Board of Directors, which shall consist of the Governor of the State, the Board of Visitors of the State Agricultural College, together with the President and the Professor of Agriculture of that institution.

3. *And be it enacted,* That the members of this Board shall be called together by the Secretary of the Board of Visitors, and shall organize by the election of a President and Secretary, who shall hold their offices for one year and until their successors are elected; five members shall constitute a quorum.

4. *And be it enacted,* That the Board of Directors shall hold a meeting each year at Trenton, on the third Tuesday in January, and other meetings at the call of the President, at such times and places as may best promote the objects of the institution.

5. *And be it enacted,* That the Board of Directors shall locate said Experiment Station and branches, and shall appoint a Director, who

shall have the general management and oversight of the experiments and investigations necessary to carry out the objects of said institution, and shall employ competent chemists, and other assistants necessary to analyze soils, fertilizers and objects of agricultural interest, so as to properly carry on the work of the Station, and it shall make an annual report of its work to the Governor of the State.

6. *And be it enacted,* That a sum not exceeding five thousand dollars in any one year is hereby appropriated to said New Jersey Experiment Station, which money shall be paid out from the State Treasury on the presentation of the bills of said Station, properly certified by the President and Secretary of the Board of Directors.

7. *And be it enacted,* That this act shall take effect immediately.

Approved March 10th, 1880.

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## CHAPTER LXXXI.

A SUPPLEMENT TO THE ACT ENTITLED "AN ACT TO PROVIDE FOR THE ESTABLISHMENT OF AN AGRICULTURAL EXPERIMENT STATION," APPROVED MARCH TENTH, ONE THOUSAND EIGHT HUNDRED AND EIGHTY.

1. BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey,* That from and after the passage of this act, the Board of Directors mentioned and created by said act shall be called and known as the Board of Managers.

2. *And be it enacted,* That in addition to the powers now conferred upon said Board, they shall have power to elect a Treasurer, who shall hold his office for one year and until his successor shall be elected and qualified; and to appoint such other officers and agents as may be necessary to carry on the business of the institution; and to make such rules, by-laws and regulations for the government of the Board, and for carrying out the objects, business and purposes of the institution, as may, in their judgment, be necessary and proper.

3. *And be it enacted,* That the annual appropriation for the support of the New Jersey Agricultural Experiment Station be and the same is hereby increased from its present sum of five thousand dollars a year to eight thousand dollars a year.

4. *And be it enacted,* That this act shall take effect immediately.

Approved March 9th, 1881.

# LAWS OF NEW JERSEY.

## AN ACT TO REGULATE THE MANUFACTURE AND SALE OF FERTILIZERS.

1. That every commercial fertilizer which shall be offered for sale in this State shall be accompanied by an analysis, stating the percentage therein of ammonia, or its equivalent of nitrogen; of potash, in any form or combination, soluble in distilled water; and of phosphoric acid in any form or combination; the portion of phosphoric acid soluble in distilled water; that portion soluble in a neutral solution of citrate of ammonia at a temperature not exceeding one hundred degrees Fahrenheit; and that portion of phosphoric acid not soluble in either of the above-named fluids, shall each be determined separately; and the material from which the phosphoric acid is obtained shall also be stated; a legible statement of such analysis shall accompany all packages or lots of over one hundred pounds, sold, offered or exposed for sale.

2. That the Chemist of the State Board of Agriculture shall be the Inspector of Fertilizers; it shall be his duty to analyze one or more samples of every kind of commercial fertilizers coming within the provisions of this act, which may be offered for sale within the State, and of which he shall be informed.

3. That manufacturers, dealers, and all persons interested, may obtain an analysis by notifying the Chemist of the State Board of Agriculture, upon which notification he shall be authorized to analyze, at his discretion, samples selected by himself, and to furnish certified copies of such analysis to the persons on whose application they were made; and it shall also be his duty to report all such analyses to the State Board of Agriculture.

4. That the Chemist of the State Board of Agriculture shall receive for each certificate of analysis made by him a sum not to exceed fifteen dollars, to be paid by the person or persons applying therefor.

5. That any person selling, offering or exposing for sale any commercial fertilizer without the analysis required by the first section of this act, or with an analysis stating that said fertilizer contains a

larger percentage of any one or more of the constituents mentioned in said section than is contained therein, shall forfeit fifty dollars for the first offense and one hundred dollars for each subsequent offense.

Approved March 24th, 1874.

SUPPLEMENT.

Sec. 1. That the penalty or penalties prescribed in section five of that act may be sued for and recovered, in an action of debt, in any court of competent jurisdiction in this State, in the name of any person who will sue for the same, one-half thereof for his own use, and the other half to be paid to the County Superintendent of Public Schools of the county in which such suit or suits shall be brought, for the use of the public schools in their county.

Approved March 31st, 1875.

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## CHAPTER CXIX.

A SUPPLEMENT TO AN ACT ENTITLED "AN ACT TO REGULATE THE MANUFACTURE AND SALE OF FERTILIZERS," APPROVED MARCH TWENTY-FOURTH, ONE THOUSAND EIGHT HUNDRED AND SEVENTY-FOUR.

1. Be it enacted *by the Senate and General Assembly of the State of New Jersey,* That the fifth section of the act to which this act is a supplement, which section now reads as follows:

"5. *And be it enacted,* That any person selling, offering or exposing for sale any commercial fertilizer without an analysis required by the first section of this act, or with an analysis stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, shall forfeit fifty dollars for the first offense and one hundred dollars for each subsequent offense," be and the same is hereby amended so as to read as follows:

5. *And be it enacted,* That any person selling, offering or exposing for sale any commercial fertilizer without an analysis required by the first section of this act, or the act to which this act is a supplement, or with an analysis stating that the said fertilizer contains a larger per-

centage of any one or more of the constituents mentioned in said section than is contained therein, shall forfeit fifty dollars for the first offense and one hundred dollars for each subsequent offense; *provided further,* that the provisions of this section, or the act to which this act is a supplement, shall not apply to any manure sold at a price not exceeding one-half a cent per pound, nor to any imported guanos.

2. *And be it enacted,* That this act shall take effect immediately.

Approved March 27th, 1878.

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## CHAPTER CCVIII.

A SUPPLEMENT TO THE SUPPLEMENT TO AN ACT ENTITLED "AN ACT TO PROVIDE FOR THE ESTABLISHMENT OF AN AGRICULTURAL EXPERIMENT STATION," APPROVED MARCH NINTH, ONE THOUSAND EIGHT HUNDRED AND EIGHTY-ONE.

1. BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey,* That section three of the supplement to the act entitled "An act to provide for the establishment of an Agricultural Experiment Station," be amended so as to read as follows:

3. *And be it enacted,* That the expenses of said Station, when presented to the Comptroller of the State, accompanied by the proper vouchers, duly certified by the President and Secretary of the Board of Directors, shall, upon warrant of said Comptroller, be paid out of the State Treasury; *provided,* such expenses do not exceed the sum of eleven thousand dollars in any year.

2. *And be it enacted,* That this act shall take effect immediately.

Approved May 9th, 1884.

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## CHAPTER CCCVII.

AN ACT TO PROVIDE FOR THE CONSTRUCTION OF A STATE LABORATORY FOR THE STATE AGRICULTURAL EXPERIMENT STATION.

1. BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey,* That the sum of thirty thousand dollars be and hereby is appropriated for the construction of a State Laboratory for the use of

the State Agricultural Experiment Station, under the direction of the Board of Managers of the State Agricultural Experiment Station, on land selected by the said Board of Managers; *provided*, such land shall be acquired without cost or expense to the State of New Jersey; which sum the Treasurer of this State is hereby authorized to pay for such purpose to the Treasurer of said State Agricultural Experiment Station, upon the warrant of the Comptroller, as bills therefor shall be presented, marked approved by the President and two members of the said Board of Managers of said State Agricultural Experiment Station.

2. *And be it enacted*, That the Chemist or Chemists of the State Agricultural Experiment Station shall analyze all samples of milk, butter or other farm products, or the imitations thereof, that may be sent to said Station by the State Dairy Commissioner and his assistants and agents, and shall report to the said Commissioner the results of such analyses, and the costs thereof shall be paid out of the appropriation made to said Station.

3. *And be it enacted*, That this act shall take effect immediately.

Approved April 23d, 1888.

## DIRECTIONS TO BE FOLLOWED IN SAMPLING FERTILIZERS.

Inspectors may sample fertilizers found either—

1. Upon farms;
2. In dealers' storehouses; or,
3. In manufactories.

The Station prefers that samples should be drawn either upon farms or in dealers' storehouses.

In sampling fertilizers found upon farms, Inspectors should ascertain—

1. That the samples are not taken from stock of a past season, or from stock which is or has been carelessly stored.
2. That they were received in good condition, and have since been so stored that a noticeable gain or loss of moisture has been prevented.

In sampling from *dealers' storehouses*, Inspectors should also ascertain whether the fertilizers are of old (last season's) or of new stock. Preferences should always be given to the present season's goods. Circumstances may, however, make it advisable to sample old stock; in such cases, this fact must be distinctly stated by the Inspector in his report to the Station's Director.

If, for any reason, it is found to be necessary to draw samples at factories, Inspectors should decline—

1. To sample from piles of fertilizers.
2. To sample from bags which are not distinctly marked with the brand, the manufacturer's name and the guaranteed analysis.

If fertilizers are found stored in piles only, Inspectors should cause six or more bags to be filled from different portions of the piles; from these bags the samples may be drawn in the usual manner.

Whenever the mechanical condition will allow, samples should be drawn by means of the *sampling tube* furnished by the Station.

It is not desirable to sample lots of less than one-half ton of any one brand. In such small lots portions may be taken from each bag; in larger lots each fifth or tenth bag may be opened. The several portions representing the same brand should then be carefully mixed and a quart fruit jar filled, securely closed and marked with labels furnished by the Station.

As soon as a sample has been taken, and *invariably* before bags of another brand have been opened, the Inspector should carefully fill out the blank describing samples.

He should copy *from the bags*—

1. The brand.
2. The name of the manufacturer.
3. The guaranteed analysis.

Other information needed for the description must be got from the owner of the fertilizer.

Each sample bottle should be separately wrapped in heavy paper and packed for transportation in a wooden box, properly closed. This box should be forwarded by express, directed to

THE NEW JERSEY AGRICULTURAL EXPERIMENT STATION,

GEORGE H. COOK, DIRECTOR,

New Brunswick, N. J.

## FERTILIZERS.

### FORM FOR DESCRIPTION OF SAMPLE.

In taking fair average samples, such as will justly represent the manufacturer as well as the consumer, it is very important that every precaution be taken, so that in case of a suit at law the person signing the description can testify to its accuracy. The writing should be plain and legible. The filled-out form, if wrapped with the sample, will serve as a label. If any printed circular, pamphlet, analysis or statement accompanies the fertilizer, or is used in its sale, send a copy with the specimen.

1. *Brand of Fertilizer*..............................................................

2. *Name and address of Manufacturer*..............................................

..............................................................................................

..............................................................................................

3. *Name and address of Dealer from whose stock this sample is taken*..............

..............................................................................................

4. *Date of taking this sample*......................................................

5. *Selling price per ton, hundred, bag or barrel*...................................

6. *Selling weight claimed for each package weighed*..............................

7. *Actual weights of packages opened*.............................................

8. *Copy of analysis or composition affixed to packages of this Fertilizer*..........

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9. *Signature*..............................................................................

(To be signed in every case by the person taking sample.)

*P. O. Address*..........................................................................

## FODDERS AND FEEDS.

### FORM FOR DESCRIPTION OF SAMPLE.

The person sending samples to the Station for analysis without charge, will be provided with a form like this for each sample, and must fill up every one of the blank particulars given, so as to make the description complete and definite, and in every case write his signature, as indorsing the accuracy of it. As there is much responsibility in taking fair average samples, such as will justly represent the manufacturer as well as the consumer, it is very important that every precaution be taken, so that in case of a suit at law the person signing the description can testify to its accuracy. The writing should be plain and legible. The filled-out form, if wrapped with the sample, will serve as a label. If any printed circular, pamphlet, analysis or statement accompanies the sample, or is used in its sale, send a copy with the specimen.

1. *Brand of Fodder or Feed* ........................................................................

2. *Name and address of Manufacturer*........................................................

....................................................................................................................

3. *Name and address of Dealer from whose stock this sample is taken*..............

....................................................................................................................

4. *Date of taking this sample*...................................................................

5. *Selling price per ton, hundred, bag or barrel*...........................................

6. *Selling weight claimed for each package weighed*.....................................

7. *Actual weights of packages opened*.......................................................

8. *Copy of Analysis or composition affixed to packages of this sample*...............

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9. *Signature of person taking sample*.........................................................

*P. O. Address*......................................................................................

## ORDER OF STATION WORK.

The largest portion of the Station work is in the Analysis of Fertilizers, Field Experiments, Feeding Experiments, with Analyses of Foods, Fodders, Milk, &c. To do these branches of work well, continuous and steady attention must be given to each of them while it is in progress, and other business has to be laid aside for the time. To make this necessary order of work as little disappointing as possible for those who desire work at the Station, we publish this statement of the subjects upon which we propose to work at the different periods of the year:

| | |
|---|---|
| Feeding Experiments | January and February. |
| Analyses of Fertilizers | March to September 15th. |
| Field Experiments | April and May. |
| Field Experiments | Sept. 15th to Nov. 30th. |
| Annual Report | December. |

Miscellaneous work of various kinds may arise to interfere with the perfect regularity of this plan, but for accomplishing the largest amount of work it will be necessary to adhere as closely to it as possible.

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| 2. June | 4, 1880. | Raspberry Disease and Suggestions for Overcoming it. |
| 3. June | 25, 1880. | Analyses of Land Plaster. |
| 4. July | 3, 1880. | Analyses of Guanos, Superphosphates and Special Manures. |
| 5. Aug. | 9, 1880. | Analyses of Bone Dust. |
| 6. Aug. | 16, 1880. | Analyses of Various Fertilizers. |
| 7. Aug. | 28, 1880. | Analyses of Various Fertilizers. |
| 8. Sept. | 6, 1880. | Analyses of Various Fertilizers. |
| 9. Oct. | 16, 1880. | Analyses of Various Fertilizers. |
| 10. Jan. | 15, 1881. | Rational System of Feeding Milch Cows. |
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| 13. May | 5, 1881. | Land Plaster and Ground Bone. |
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| 18. Dec. | 20, 1881. | Sorghum Sugar Cane. |
| 19. Feb. | 20, 1882. | Green Fodder Corn; Dried Fodder Corn; Ensilage. |
| 20. March | 30, 1882. | Valuation of Fertilizers. |
| 21. July | 10, 1882. | Chemical Fertilizers (Incomplete). |
| 22. July | 28, 1882. | Commercial Fertilizers (Complete and Incomplete). |
| 23. Oct. | 10, 1882. | Commercial Fertilizers. |
| 24. Nov. | 25, 1882. | Sorghum; Feeding Experiments with Sorghum Seed. |
| 25. Dec. | 8, 1882. | Sorghum and Sugar; Experiments and Investigations of 1882. |
| 26. Jan. | 4, 1883. | Field Experiments. |
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| 28. July | 2, 1883. | Analyses and Valuations of Complete Manures and Special Fertilizers. |
| 29. Aug. | 2, 1883. | Analyses and Valuations of Nitrogenous Superphosphates, Ground Bones, Plain Superphosphates, Poudrettes and Miscellaneous Fertilizers. |

30. Nov. 16, 1883. Results of Field and Laboratory Experiments with Sorghum, for the Season of 1883.
31. Dec. 22, 1883. Nitrate of Soda or Chili Saltpeter as a Top Dressing for Wheat.
32. March 28, 1884. Prices of Nitrogen, Phosphoric Acid and Potash.
33. Aug. 2, 1884. Analyses and Valuations of Complete Fertilizers.
34. Sept. 27, 1884. Analyses and Valuations of Incomplete Fertilizers.
35. July 1, 1885. Meaning of Stations' Valuations, Schedule of Trade Values for 1885, Chemical Composition, Retail Prices and Guaranteed Analyses of Fertilizer Supplies.
36. Oct. 2, 1885. Analyses and Valuations of Complete Fertilizers.
37. Dec. 7, 1885. Miscellaneous Fertilizers.
38. Dec. 21, 1885. The Rio Grande Sorghum Sugar Works.
39. March 19, 1886. Meaning of Stations' Valuations; Schedule of Trade Values for 1886.
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41. Jan. 22, 1887. The Extraction of Sugar from Sorghum, at Rio Grande, Cape May County, New Jersey.
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43. Dec. 31, 1887. Analyses and Valuations of Complete Fertilizers, of Ground Bones and of Miscellaneous Material.
44. March 8, 1888. Sorghum and Sugar-making; a Report upon Experiments made at Rio Grande During the Season of 1887.
45. March 10, 1888. Prices of Nitrogen, Phosphoric Acid and Potash.
46. May 23, 1888. Insect Pests and the Means for Destroying Them.
47. June 23, 1888. Analyses and Valuations of Incomplete Fertilizers.
48. Aug. 7, 1888. Analyses and Valuations of Complete Fertilizers.
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50, Dec. 5, 1888. Insects Injurious to the Cabbage and the Best Means of Preventing Their Ravages.
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